SCIENCE EDUCATION

Formerly GENERAL SCIENCE QUARTERLY

SERVING TEACHERS IN ELEMENTARY SCHOOLS, JUNIOR AND SENIOR HIGH SCHOOLS, COLLEGES, AND PROFESSIONAL SCHOOLS FOR TEACHERS

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SOME ASPECTS OF GERMAN EDUCATION IN THE U. S. ZONE OF OCCUPATION

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ONE of the least publicized aspects of the American occupation of parts of Germany has been the reconstruction of German education under supervision of our Military Government. While events in the political and economic spheres have produced a considerable amount of commentary, both critical and favorable, the program of reviving German education at all levels has been overlooked for the most part, despite the fact that it comprises a basic course of action in the Allied endeavors to eliminate Nazism and militarism from the German scene, and also despite the fact that considerable gains have been scored in the face of almost hopeless odds confronting the Military Government officials concerned.

Occupation of any German community by U. S. troops was followed at once by the closing of all educational institutions, in order to permit an orderly appraisal of existing teaching staffs, curricula, and textbooks. No school was permitted to reopen until its staff had been purged of all active Nazis and until courses and books deemed objectionable from the American point of view had been completely eliminated. The reopening of the schools followed a schedule worked out in advance and was undertaken according to types of schools found in Germany. While, however, the majority of schools in any given category were opened according to plan, many individual schools had to open much later, thanks to particular local problems existing in the community in question.

Elementary schools (school age 6–14) were reopened as a group on October 1, 1945, although an acute shortage of trained teachers required a widespread use of instruction on alternate days or of teaching classes in shifts. Secondary schools, comparable to our high schools, were delayed in their reopening not only by widespread damage to physical plants, but also by the fact that a very high proportion of their staffs had to be dismissed by reason of being active members of the Nazi Party. Adult education, always very popular in Germany, also suffered considerable delays in resumption of instruction, thanks to heavy Nazi indoctrination of surviving staffs. Institutions of higher learning were reopened rather late, owing to considerable problems of denazification and student selection.

Approximately one year after the surrender of Germany, the German school system in the U. S. parts of the Reich presented the statistical picture found on the following page. While the statistics appear quite favorable, certain items among them require additional explanation.

The shortage of trained teachers still represents the most urgent problem among the many besetting German schools in the U. S. Zone of Occupation and the U. S. Sector of Berlin. In some communities, as many as 85 per cent of all former teachers had to be dismissed by Military Government, owing to the fact that they had been active Nazis. This meant that, at all levels of education, a very small corps of trained

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teachers remained, totally inadequate in their numbers to take care of the influx of students. As a result, administrators not only had to hire retired teachers but had to employ thousands of untrained adults, called "school assistants" (Schulhelfer). The latter group, usually without any education training in their background, was exposed to a brief course of "orientation" lectures and then told to go ahead and teach; usually, these assistants taught then for five days each week and went to school under the experienced teachers on Saturday mornings. Needless to add, the quality of instruction left much to be desired under such conditions! As a result of employing large numbers of retired teachers and adult assistants, the average age of teachers in the elementary schools was between 55 and 60 years of age for males and slightly lower for female teachers, as of May 1, 1946. Many of these persons, in the more remote rural areas, had as many as two or three complete schools in their charge, which meant that even in wintertime they had to bicycle from village to village, teaching a few hours each day, or on alternate days, in each school in question.

(STATUS AS OF MAY 1, 1946)

	Elementary Schools	Secondary Schools	Special * Schools	Vocational Schools
Students in school	1,895,706	169,143	4,751	139,521
Students not yet in school	135,654	4,786	393	19,590
Percentage of students in schools	93.3%	97.3%	92.4%	87.7%
Teachers employed **	23,825	5,349	188	2,267
Add. teachers needed to resume normal operations	12,324	2,584	69	1,637
Students per teacher	79	32	25	62
School plants in use	9,756	402	35	395
Schools housed in temporary quarters	205	106	3	56
School plants usable but utilized for other purposes	408	91	5	56
** Including in this total "school assistants" as follows	4,421	540	9	87

* Special schools are schools for the blind, deaf and dumb, and similarly handicapped children.

During the first winter of operation, many of the schools in the rural areas and very small towns remained open for only fifteen or thirty minutes per day, just long enough for students to turn in their homework from the previous day and to receive new assignments for the following day, inasmuch as no fuel could be found to heat the school plants. In certain other communities, each child, as the "price of admission" to daily classes, had to bring a stick of wood to school so that the building could be heated. In the larger cities, where central heating prevailed in large school plants, heating by means of wood was found to be impracticable, and classes were held, for minimum periods each day, in unheated rooms. As a result, very many schools that had reopened in the fall and early winter of 1945 closed again for the duration of severe cold spells, with resultant deterioration of instruction and an inability to "catch up" for the lost weeks when Spring came at last.

Despite vigorous efforts on the part of both Military Government and the German school authorities, resumption of teacher training progressed but slowly during the first year of occupation. While a large number of teacher training institutions were in usable physical condition, much equipment had been lost or stolen during use of the buildings by outsiders, and, above all, there existed a continuing dearth of teaching personnel. This was owing to the fact that during the Nazi regime, teacher training institutions had been permeated by Nazi ideology to an even greater extent than had been the case with the elementary and secondary schools. Finally, however, by May 1, 1946, some 35 training

institutions had resumed instruction, with a total enrollment of over 6,100 students, and a considerable number of additional institutions have received permission to reopen, once adequate staffs had been found. It was estimated at the time that, thanks to "short courses" and other expedients, slightly more than 3500 teachers could be graduated from these schools in 1946–47 to help to fill the gaps in the German school systems.

A second grave problem faced in the reconstruction of German education was the enormous shortage of textbooks for school use. Not only had many texts been destroyed with the physical plants, but a very large proportion of remaining texts could not be used because of Nazi ideas and militarist indoctrination found therein. Some easement of the shortage was obtained early during the reopening of the elementary schools through the procurement of over 5,000,000 copies of pre-Nazi texts (some 20 titles) selected by Military Government officials beforehand from the large reference collection of Teachers College, Columbia University. These texts had been selected, not necessarily as the best, but as the best obtainable in short order. Plates for their production had been produced in England, and the actual volumes were printed in Munich—ironically enough, on the presses that, before the fall of Germany, had turned out the "Voelkischer Beobachter", south German edition, that is, the official Nazi Party newspaper for Bavaria. The various states in the U. S. Zone of Occupation purchased these texts from the Bavarian Government and distributed them among their various elementary schools. In addition, each German school system finding itself with a supply of textbooks still intact was asked to send a copy of those deemed acceptable to a special censorship office set up by Military Government in Berlin. That office "screened" the texts submitted and published a list of those found to be acceptable as printed, or acceptable, subject to minor revisions. It also published a list of books that could not be used. The percentage of rejected texts was relatively low, inasmuch as the German authorities tended to submit only those texts which they thought would be acceptable to Military Government. Nevertheless, almost all arithmetic texts had to be rejected, since the traditional problems had been supplanted by problems dealing with such things as troop trains, trajectories of shells, underwater travel of submarines, etc. Many Latin texts had to be eliminated, since the classic writings of Tacitus and Caesar had been supplemented by chapters extolling the military virtues of Romans and Germanic tribes; almost all texts for the training of nurses, as well as most biology texts, had to be rejected, thanks to the infusion of liberal doses of virulent racialist propaganda. Quite a few chemistry texts had to be eliminated also, for even in this field the ideologies of Nazism and militarism had been included.

Military Government tried its utmost to stimulate German production of new school texts, freed of the Nazi incubus, but until very recently the best that had been submitted in the way of manuscripts could only be dignified by the term "paste and scissors" productions, with few new or democratic ideas, if any, found in the works submitted. In addition, the very critical paper shortage has hampered the production of new texts, despite allocation of whatever could be spared in the way of paper to school text production. A final handicap to the production of new texts, particularly in the field of sciences, has been the fact that most publishing houses that dealt in science texts, particularly in the field of medicine, were located in Leipzig, in the Russian Zone, and had either been destroyed in the course of the war or were unable to produce texts for the U. S. Zone of Occupation.

The teaching of courses in the mathematical and physical sciences has been severely handicapped in all German schools

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under our administration not only by the shortage of acceptable texts, but especially by the shortage of laboratory equipment. A good deal of glassware, test tubes, retorts, tubing, etc. has been smashed into rubble by bombing or by irresponsible temporary occupants of school plants. Electrical equipment, tools, wire, even nails, had disappeared during the turbulent days prior to the reestablishment of law and order, those carefree days when "moonlight requisitioning" was not confined to members of various armed forces but also to any and all German civilians, as well as displaced persons. Furthermore, replacements for the lost or destroyed equipment are virtually impossible to obtain, and as a result most German instruction in scientific subjects has been reduced to demonstrations on the blackboards . . . where blackboards remained! The students in these, as well as all other, courses are further handicapped by the shortage of notebooks, and the writer observed in many instances the use of the same notebooks by successive generations of students: at the end of a course, a line would be drawn under the last problem, and the notebook would be turned over to a student in the incoming class for use with different problems, so that the student completing a course would have no record of his past experiments, lectures, and problems, with no chance for reviewing past subject matter while taking the next higher course in the same subject.

Student morale in many of the elementary, secondary, and vocational courses was not too high during the first year of school operations. The younger generations of Germans were sorely puzzled by the fact that everything that had been drilled into them as the highest ideals, maxims, and wisdom, suddenly proved to be discredited, disreputable, even criminal. Young minds found it difficult, and sometimes impossible, to adjust themselves to this sudden reversal which called for a complete reorientation in their thinking. Also, many former members of the Hitler Youth (to which all German children used to belong, by law) found the new life and the new schools rather dull, since the glamour of uniforms, of Party ceremonies, of pageants, of solemn dedication to the Fuehrer and to the Party, now had disappeared from their lives. It is quite understandable, therefore, that many of them longed for the former excitement and activities. And, lastly, the fact that so many old and/or untrained teachers had to be employed to make possible the bare reopening of the schools provided all too many problems of discipline and made life for both teachers and serious pupils difficult at times, to put it rather mildly!

German higher education in the U. S. parts of the Reich resumed instruction somewhat later than the elementary and other public schools, thanks to the need for a very careful investigation of all staffs, of all curricula, and of the prospective student bodies. By May 1, 1946, six of the seven universities in the U. S. Zone had reopened, with only the University of Giessen closed, thanks to damage to physical plant. In view of the fact that the medical and theological faculties had been reopened before all others, tremendous enrollments had been observed in those two fields; it was expected, however, that gradually a number of students would transfer out of those courses into other fields, once facilities in the latter had been opened up completely. Out of a total enrollment of 20,040 on the above date, 4,024 students were enrolled in Philosophy (including "Humanities"), 3,236 in law, 8,208 in medicine, 2,934 in the natural and physical sciences, 691 in theology, and 947 in the social sciences.

The four colleges of engineering in the U. S. Zone, at Darmstadt, Karlsruhe, Stuttgart, and Munich, had also been reopened by the middle of 1946, with a total enrollment of 7,302 students. These schools suffered particularly from shortage of equipment, thanks to the preponderance of laboratory work entailed in their instruction. As a result of the impossibility of replac-

ing lost or destroyed equipment, a very considerable proportion of all instruction, even in these technical schools, had to be carried on solely by the lecture and blackboard demonstration method, and many members of the staffs expressed grave doubts as to the value of the training received by the prospective engineers studying at these schools.

By May 1, 1946, only the college of engineering at Karlsruhe had received permission to resume scientific research in six institutes/departments. Each project contemplated had to be approved in advance by Military Government, after a formal application had been submitted, and continuing reports on progress made were required for each project approved.

The control of research in the natural sciences in the scientific institutes and departments of colleges and universities in Germany is regulated by the provisions of Allied Control Council Law No. 25, enacted in April 1946. This law has been designed solely from the point of view that all German war potential must be eliminated. As far as actual control of research is concerned, a Research Control Office has been set up within the framework of Military Government, with regional offices scattered throughout the U. S. Zone. Applications for the reopening of a research institute and for the undertaking of scientific research projects would then be submitted to the regional office nearest to the college or university, and periodic reports on progress achieved would then be channelled through Military Government to the central office. The whole field of scientific research at German institutions of higher learning was one that had not yet been completely cleared in Military Government planning, at the time of the writer's return to the United States, inasmuch as detailed rules and regulations would have depended on a more exact knowledge of future German reparations, on a reorganization of German scientific education, on the size of research programs planned by German scientists, and on the nature of the research contemplated by them. Also, complicating factors, such as the future nature of Germany's foreign trade, played an important part in delaying the issuance of detailed instructions and regulations governing future scientific research at German institutions of higher learning.

All German institutions at the college or high levels suffer common problems in the sphere of research material. After having been shut off from information concerning foreign research and scientific advancement for many years, and after having suffered heavy losses in their own library resources as a result of bombing and other destruction, German institutions of higher learning have found it exceedingly difficult to open up channels through which they might obtain current and past materials on the various fields of knowledge from abroad. While certain shipments of materials have gone to them as gifts of Military Government officers connected, in civilian life, with American educational institutions, or directly from American learned societies or colleges, the flow of such shipments has been very slow and has taken place only recently in any appreciable volume. Hence German professors and scientists have clamored in vain for up-to-date information and have taught with a pronounced feeling of inferiority concerning the quality of their teaching and of their knowledge.

It should be emphasized that the quality of teaching staffs at German institutions of higher learning, in the U. S. Zone, has remained surprisingly high, despite a rigorous "purge" of the many active Nazis who had occupied professorial chairs in the various schools. In some instances a very large number of professors had to be dismissed because of past affiliations or activities (at the University of Marburg, for instance, the entire faculty of the Dental School had to be fired without a single exception), and for a while it looked

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as if many fields of learning would have to be suspended for lack fo teaching staffs. However, a number of acceptable staff members were found among those retired under Nazism, quite a few men of high caliber and political reliability were acquired from the Russian Zone of Occupation whence they came through official channels or "unofficially" (some fascinating stories could be told, by some members of Military Government, about how certain individuals were made available to German universities in the U. S. Zone!), and a surprising number of refugee and exiled German professors applied to Military Government for permission to return to the U. S. and British Zones in order to accept invitations received from institutions of higher learning to resume their teaching careers in Germany. The writer himself saw such applications from all over the world—India, Egypt, Chile, France, Great Britain, to name but a few places from which former German teachers sought to return to their native country in order to rehabilitate its system of higher education. Some of these individuals have received permission to return, after careful investigation, and have already resumed their teaching activities in western Germany.

Student morale at colleges and universities is high, despite rigorous conditions of life, appalling housing conditions, and poor food supplies. At some colleges, such as at one in the Russian Sector in Berlin and another one in the British sector of the same city, student participation in clearing away rubble on the college campus was made a preliminary condition of admission. Everyday necessities of life, including even such things as light bulbs, are practically unobtainable and have to be either "scrounged" at the expense of attendance at lectures, or have to be brought from the students' parental home. Textbooks are virtually impossible to obtain, especially such as contain diagrams, plates, etc. Atlases of pre-Hitler days are practically non-existent, and anatomy texts and plates are treated with the same reverence as a Gutenberg Bible!

Some American national magazines have charged, in surveys of German colleges, that rank nationalists exist on every campus; that, to the best of the writer's knowledge, is quite true, but their proportion is not very large when compared with the total enrollment. Nationalism, even of the mild kind called patriotism, is not a thing that can be wiped out overnight in a person's intellectual make-up, and it should not be surprising that, after 12 years of Nazism and after preceding decades filled with the preaching of German nationalism, present-day German university students still count among their ranks a large number of nationalists. It can only be hoped that, after due exposure to democratic teachings and after viewing the debacle of German nationalism through two disastrous wars, the present generation of German university students may acquire a different outlook on political questions than was held by their immediate predecessors.

A very large number of university students, furthermore, refuse to accept the doctrine, preached by such men as the famous Pastor Niemoeller, that every German, old or young, high or low, Nazi or non-Nazi, shares with all his fellow Germans the guilt for German aggression and for German war and other crimes. Time and again large bodies of German students have either walked out on Niemoeller's lectures or have vocally expressed their lack of belief in the idea of universal German guilt. This is not too surprising, for the same attitude is found, in general, among all other groups composing the German public, even today. Each one, with few exceptions, points at some other group, preferably at a former Nazi, with the finger of scorn and attributes guilt to the group or person in question, while maintaining vociferously that he, or she, the pointing one, is of course entirely free of guilt and should be ranked with the innocent victims of

"them" or "they". Again, like nationalism and similar beliefs, or lack of beliefs, such attitudes cannot be eradicated in a short while. That is but one of the many reasons advanced in support of the idea that Military Government supervision over education, media of public information, and many other aspects of German national life will have to be maintained for a long period of time, until, in fact, a whole new generation of Germans has gone through a period of schooling and exposure to factual and unbiased information and can have emerged with a new and more wholesome outlook on life in its economic, political, intellectual, and spiritual phases.

SOME TRENDS IN SENIOR HIGH SCHOOL SCIENCE WITH IMPLICATIONS FOR THE PREPARATION OF TEACHERS *

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MAY I preface my remarks by stating that there are available to me all too meager and incidental bases for judging trends in science teaching. There are a number of persons in this conference who have more extensive and more adequate bases for identifying trends.

There is a trend toward modernization of high school science courses of study. In a study completed last spring, our office discovered that 8 states or territories had recently revised one or more of their high school science courses of study, and 20 states or territories had plans to undertake such work within one or two years. Several other states were encouraging science teachers to undertake the revision of their own courses of study although no statewide courses of study were desired. Are we providing our science teachers with the understanding and skills they need to engage effectively in curriculum revision work?

There is some evidence to indicate that many preflight and aeronautics courses that came into school programs of studies during the war have been relegated to club activities or dropped entirely. Furthermore, some of the emphasis on aviation that was accepted by teachers of various subjects as a war emergency is no longer included in their courses. There is also evidence to indicate that many other schools have expanded their aviation offerings and have developed aviation rooms well equipped for effective aviation instruction. Some schools have brought their program to the point where actual flight is provided as a laboratory experience.

In the readjustment of school curricula to peacetime conditions there is a distinct hazard that the vitality which aviation gave to the high school program in general and to science courses in particular may be lost. Aviation concepts and applications cannot be divorced from science courses without weakening the science courses. Special aviation courses should not be dropped from the high school program simply because the war is over since aviation progress will continue to affect all Americans in a very significant way. Are we in our teacher training giving adequate and proper recognition to the scientific and social implications associated with aviation?

In a prominent eastern state, there has been an increase in the number of students studying science in spite of the fact that there has been a decrease in the total high school enrollment. Much of the increase has been in advanced science and science subjects other than general science, biology, physics and chemistry. Advanced

* A report of informal remarks presented at the meeting of the Eastern Conference on Teacher Training in Science, New York, N. Y., November 14, 1947.

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science, advanced biology and other offerings as eleventh and twelfth grade courses for general students have shown very startling growth. There is only one state, to my knowledge, that has recognized physical science in its course of study, although there is an increasing amount of endorsement for high school physical science for general students in preference to physics and chemistry. The problem of arranging and teaching science courses that meet the needs and interests of general students is not an easy one to solve. Selecting appropriate subject matter is a problem. Using appropriate plans and methods is difficult. Planning experiments for demonstration and for individual and group work is difficult. Selecting and using library and audio-visual aids is difficult. Surveying and using community resources is difficult. Winning administrative and parental approval is difficult. Are we training our teachers to develop and teach eleventh and twelfth grade integrated courses for general students?

While in California two years ago, I discovered that one high school had more sections and more students enrolled in photography than in physics. There are, of course, a very large number of photography clubs and the trend seems to be upward in number. Are we, in our teacher training, giving our students the help they need to understand and apply the sciences related to photography both in regular courses and as club activities?

There is a strong trend in the direction of making plans for new high school buildings. These plans and the buildings which follow will condition for better or worse science teaching for a generation or so. There are new developments in semi-micro methods for teaching chemistry which can also be applied to a considerable extent in other sciences. Semi-micro methods can easily be instituted if planned for in new buildings, but more difficulty is encountered if adapted for an old building. Some schools have, through reorganized science courses for general students, expanded their science enrollment several hundred per cent requiring more rooms, more teachers and more equipment and supplies. All too many science courses, especially general science, are now taught in ordinary classrooms without water, electricity, sewage, gas, opaque shades and other experimental and visualizing facilities. Now is a time to have foresight in making basic provisions for effective science teaching. Are we helping our science teachers in training to see what a modern science lay-out should be like to adequately recognize the proper and possible place of science in the education of all youth?

There is, as all of you know, a very greatly increased interest and emphasis on finding and nurturing students with talents suitable for scientific careers. Such students are likely to be found in any school but the rate of occurrence is very low. In the kinds of schools that our inexperienced teachers will go into, there will be, in most cases, no administrative plan to give special attention to talented students. The teacher will have five classes with twenty to forty students and most of the finding and nurturing of science talent will have to be done in these classes. This means that the teacher needs to understand and be able to arrange and guide individualized instruction in the form of contracts, individual mastery units, individual projects, group conference plans, and other schemes whereby pupils follow study guides prepared in advance by the teacher and used in the classroom for supervised study, leaving the teacher free to guide superior students and assist inferior pupils. Are we in our teacher training helping our pupils to arrange individual instruction guides and do we give our teachers experience in conducting classes by individualized study plans? Are we, in our teacher training, providing for our students the examples and instruction useful in identifying students with scientific talents and, are we revealing how such talents may be effectively nurtured?

There is a growing emphasis on camp-

ing and other forms of outdoor education as a planned part of the school experience of all youth. Many schools operate day camps during the summer and some schools own tracts of land which they are developing for educational uses. Along with these more extensive possibilities are a host of local possibilities of improving school grounds through erosion control, and beautification by plantings. Are we, in our teacher training work, giving our students opportunities to understand and to gain experience in the possibilities of the out-of-doors for effective science education?

With increased salaries for teachers and other school personnel comes a difficulty of getting sufficient funds for supplies and equipment. Then too, there is a trend toward higher prices for supplies and equipment. As I visit schools, I notice all too often a depressing lack of care for science instructional materials. I cannot tell whether there is a trend toward better or poorer care. I do feel that there should be a trend toward better care because care of equipment is a very obvious evidence of the functioning of scientific attitudes. Furthermore, moneys for supplies and equipment will be more readily obtained when there is obvious evidence of reasonable care than when there is evidence of confusion, meager use, and wanton carelessness. Are we, through example, instruction, and experience, teaching our teachers to give proper care to supplies and equipment? Are we teaching them how to order new materials and repair damaged equipment? Do the practice situations we use reveal the proper care of scientific instructional materials?

There are many persons who blame science instruction for much of the mess the world is in. There are parents and there are leaders who wish to have pupils excused from science studies or from portions of science studies on the grounds that the teachings are contrary to religious beliefs. There are also many people who have a grossly exaggerated notion concerning the dependability of so-called or inferred scientific pronouncements and a great criticalness of the so-called eternal verities. Whether there is a trend toward or away from materialism in this country, I do not have more evidence than you do. Nevertheless, I do judge that there is in this realm a place for science teachers to demonstrate by words and actions a proper regard for science and a proper understanding of other values. They should understand the comparative dependability of hypotheses, theories, principles and laws and they should associate these labels with the scientific ideas which are discussed in science classes. They should also appreciate that there are values other than those measurable by the objective measures of scientists and those so often labeled by the American dollar. Are we, in our teacher training, sensitizing our teachers to the problem of values and are we helping them to teach science so as to undergird the values which are the foundations of American democracy?

These may be some of the trends. There may be others related to size of classes, amount of time available for instruction, the planning for science in core curricula, the reorganization of science into community studies, the inclusion or exclusion of health instruction through science, and the like.

There is little doubt in my mind that teacher training institutions should give serious considerations to at least four trends:

1. The training of teachers to extend science to all students for their general education.
2. The training of teachers to recognize and nurture scientific talent.
3. The training of teachers to be more scientific in their approach to problems and to their use and storage of equipment.
4. The sensitizing of students to the limitations of science and to the contributions of other values.

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VARIABILITY IN RECOGNIZING SCIENTIFIC INQUIRY *

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INTRODUCTION

MY paper concerns the scientific method of inquiry. If I refer to an article about "Bats and the Scientific Method," some of you may think that I have arrived—rather speedily—at the proper conclusion. Permit me to forestall such untoward thoughts. There actually is such a paper. The word "bats" in the title refers only to the mammals which really fly; not to those who present papers on programs such as this.

In the paper which has been cited, John Mills uses the studies made by Galambos of the flight of bats in order to draw the following conclusion, among others, viz.:

> The experimenter varies only one condition at a time in order to be able to say: *"Other things being equal,* a change of so much produces such an amount of effect." Only under those conditions does he assume to draw a valid conclusion. In most of the experiments of modern science the expensive, time-consuming task is this elimination of any irrelevant and uncontrolled factors.[1]

As a characterization of desirable experimental design, Mills' statement probably would receive approval from educators generally, and from many science teachers in particular. Stimulate one of them with the term "educational experiment"; the response probably would be "matched pairs." Although the Horace Mann-Lincoln School is scheduled to be terminated this spring (1948), it may be worth remarking that those who designed the Lincoln building are said to have had controlled experiments in mind when they provided two of everything—one for the experiment and one for the control.

For the group present here today, however, the value of the procedure which Mills has described so aptly should be questioned. Such single-factor designs in agricultural research have been condemned by Fisher and his students as being inefficient usually and sometimes futile.[2] The work to be described hereafter exemplifies the importance of multiple-factor design in educational experimentation. Also, it clarifies certain conceptions regarding scientific inquiry.

BRIEF STATEMENT OF THE PROBLEM

An analysis has been made of selected textbooks in high school science. The specific questions asked included the following:

> What is the scientific method of inquiry?
> Have the authors of selected high school science texts explicitly accepted the scientific method of inquiry?
> What ideas related to the scientific method of inquiry were discussed, assumed, or exemplified in the books?
> By what means were the said ideas presented?
> How much space was given to them?
> Was variation in amount of space given to scientific inquiry associated with variation in factors such as the following:
>
> - Subject field of the book; e.g., general science?
> - Topics within subject fields?
> - Authorship, or variation from book to book?
> - Position within the book, from quarter to quarter?

These questions grew out of the view that scientific inquiry is generally accepted as an educational objective, that textbooks powerfully influence teaching, and that suggestions for improving textbooks might help to improve science instruction.

OUTLINE OF THE WORK

A detailed formulation of scientific inquiry was prepared. Since this phase of the work will be described elsewhere, it

* Paper presented at the Atlantic City Meeting of the National Association for Research in Science Teaching, February 23, 1948.

A full report of the study on which this paper is based is being published as Teachers College, Columbia University, Contributions to Education, No. 955.

[1] Mills, John. "Bats and the Scientific Method." *American Journal of Physics,* 11:151–153 (June, 1943).

[2] Fisher, R. A. "The Factorial Design in Experimentation," *The Design of Experiments,* pp. 100 *ff.* Edinburgh: Oliver and Boyd, 1937.

should suffice here to say three things about it. First, the formulation suggested specific ideas, as well as kinds of ideas to look for. Second, it served the readers as a coding guide. Third, it provided a framework for tabulating and reporting data.

Twelve high-school science textbooks —three each from the fields of general science, biology, physics, and chemistry— were selected for analysis. They were believed to be widely used products of standard authors and reputable publishers.

Examination of the prefaces showed that seven of the twelve had claimed scientific inquiry as a direct objective, three as an incidental objective, and two had claimed it not at all. Those in the first class claimed that all or most of the material to be read by students contributed to the objective; in the second, that the activities suggested for students assisted, or sufficed for, attainment of it.

For analysis of the content of the textbooks, various procedures were considered. For example, one person could have read all the textbooks. Or several persons could have read one textbook each. Or several persons could have read portions of two or more books each. Other possibilities may readily be imagined.

Each plan in prospect had certain advantages and disadvantages. The plan of having several readers was adopted because—when coupled with proper design of the experiment—it permitted elimination of several kinds of bias, permitted statistical tests of the significance of obtained results, and permitted securing of information about interactions.

It was decided to have twelve readers, each reading a unique composite textbook constructed as follows. Each of the twelve selected textbooks was divided physically into forty-eight fragments which were numbered serially as they appeared. These fragments were reassembled into composite books with careful control of three factors, to wit:

First, each book appeared as a fragment once and only once in each of the twelve positions in each quarter of the composites. Also, the particular order of fragments within any quarter of any composite was a random selection of all possible orders.

Second, the relative order in which the four fragments from any one book were placed in a given composite was a random selection from the twenty-four possible orders. Also, there was no duplication of relative order of textbook fragments, either in fragments of the same textbook in the various composites, or in fragments of various textbooks in the same composite.

Third, each composite contained one and only one first fragment from a textbook, and similarly for other serially numbered fragments.

The first and third factors were arranged by use of successive 12 x 12 Latin-Greek squares; the second, by a specially constructed table. From the details already given, it will be realized that each composite was as long as a standard science textbook, but contained forty-eight fragments—one from each quarter of each of the twelve source textbooks.

There were twelve readers, six majors in science teaching and six in philosophy. They were carefully chosen on the basis of faculty recommendations; later, a test of general intelligence showed the readers to be a select group of high intelligence. Each reader was given a composite, a coding guide, and detailed written instructions. He was asked to put brackets around each package in his composite which he considered to be related to scientific inquiry, and to show by appropriate code number the particular aspect of scientific inquiry on which the passage bore.

The readers were not required to agree with the positions taken in the coding guide on various questions, nor were the textbooks required to agree. It was necessary only for the readers to understand

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the questions discussed in the coding guide, and to use the code number for a particular point whenever a pertinent textual passage was bracketed—no matter what position was taken therein and no matter what their personal views were.

Two independent tests were made of the ability of the readers to do the tasks set for them. First, each reader coded a set of sixty passages quoted from texts not included in the main study. Second, each reader coded—at the center of his composite—a fragment common to all composites.

THE FINDINGS AND SOME APPLICATIONS THEREOF

Variability Among the Readers

On the coding test and on the common fragment, each of the twelve readers covered precisely the same material. They often applied different rubrics to the same passage; in other words they could not agree on what aspect of scientific inquiry was being discussed therein; also, in terms of arbitrarily established correct responses to test items, their mean test score was scarcely half the possible.

Even more fundamental was their failure to agree on bracketing, that is on whether any aspect of scientific inquiry was referred to. Their net agreement on bracketing only the textual material from the common fragment was less than one-third.

On the composite textbooks, the readers' work showed significant variation attributable to their backgrounds in science and philosophy, and also variation attributable to other background factors not disclosed.

One who has digested these data may speculate as to the possibly misleading results that might have been obtained with different reading procedures. If only one person had read all the books, who could have told what part of the obtained data had come from the books, and what from the reader? If several readers had been assigned one textbook each, probable variation among the readers might have been ascribed to the books or to the subject fields.

In this study, the original interest was in the textbooks. Hence, several things were done to minimize reader variability. But, perhaps the greatest value of the study would have been lost if thereafter reader variability had been assumed to be negligible. Through multiple-factor design of the experiment, entirely independent sources of variation were revealed in readers' backgrounds of science teaching and philosophy, in other undisclosed reader characteristics, in the subject fields of the textbooks, in other undisclosed book characteristics, and among the quarters of the composites; no interaction was shown to be significant.

Possibly the most important inference to be drawn from the findings about reader variability is that the task of analyzing textual material for conceptual content is extremely difficult. Consider the present study, for example. There was at hand a detailed formulation of the ideas being sought, namely those pertaining to scientific inquiry. Assume that the readers had mastered such formulation. Then, concerning all the textual matter which they surveyed, the readers were required to answer these questions:

> Does any of this pertain to the scientific method of inquiry?
> If so, to what aspect of it?
> What is the code number for expressing such aspect?
> How much of the text is pertinent to such aspect?

Suppose that a specific passage in the text was *known to be pertinent* to a certain aspect of scientific inquiry. Then possible reactions to such passage included the following:

> It might have been considered pertinent to such aspect and been bracketed and coded accordingly, or
> It might have been considered pertinent to such aspect but have been coded to some other aspect, or
> It might have been considered not pertinent to scientific inquiry, or

The text material pertinent to such aspect might have been considered to have different positions of beginning and ending, or
The like.

On the other hand, suppose that a specific passage was *known not to be pertinent* to a certain aspect of scientific inquiry; then possible reactions also were as above.

The readers were carefully selected; their failure to agree, even with the aid of a detailed formulation of scientific inquiry, is considered not evidence that they should be criticized, but rather evidence of the difficulty of the task that was set for them.

The findings on reader variability have obvious application to earlier researches, particularly those which attempted objective formulations of scientific inquiry. They apply both to the stage in which elements of scientific inquiry were derived by scanning the literature, and to the succeeding stage in which the derived list was evaluated by judges. In the former, the investigator's philosophical experience and tastes—if not the limited contents of his libraries—surely influenced his selection of background material to scan for suggestions; this limitation seems severe, but its restrictive effect was multiplied by the principle that only those ideas which the investigator deemed important were offered for the consideration of the judges. In the latter stage, it is doubtful that the judges interpreted given items uniformly; therefore, summations of their responses to such items would seem to have little validity even as a measure of what the judges thought.

Also, the findings on reader variability affect the value of various reports of controversial materials in print. Are certain textbooks un-American? Are they pro-Nazi? Anti-union? A convincing answer to such questions now requires a detailed formulation of the characteristic in question, plus an analysis of the materials, plus evidence that the results reported are verifiable, that they have been freed from the effects of projection by the analysts!

Another possible inference from the findings on reader variability is that the readers were not familiar with certain aspects of scientific inquiry. Are the ideas discussed in the detailed formulation too difficult for science teachers to grasp, or too elusive for use in setting up teaching-learning activities? It is suspected that many of the ideas in the detailed formulation are now written into standard textbooks, either affirmatively or negatively, although data from the present study can not be used to support this suspicion because of the large reader variation confounded with the book data. Also, it seems likely that affirmation or negation of such ideas is part of the thought patterns of ordinary people. If we remember that scientific inquiry is one way of knowing, of acquiring beliefs, and that all of us are in fact acquiring beliefs, then we must conclude that we use either scientific inquiry or one of the competing ways of fixing belief such as authority, intuition, or tenacity. Before assent is given to suggestions that progress toward the scientific inquiry objective is impossible because of the difficulty of the concepts and because of their separation from everyday living, one would like evidence in support of such ideas.

Clearly, the hypotheses of difficulty and remoteness do not exhaust possible explanations for lack of progress. One might ask whether institutions preparing teachers have done their part in the area? An impromptu survey of agencies which teach, or have taught in the area of scientific inquiry, has shown no offering in a teachers college. It is a serious question whether prospective science teachers have adequate opportunity to acquire competence in this area. If they don't, shouldn't they be given such opportunity?[3]

[3] Lampkin, Richard H. "Scientific Inquiry in High School Science Books." Paper presented during the Twenty-first Conference on the Education of Teachers in Science, at Teachers College, Columbia University, November 14–15, 1947. To be published in March, 1949, SCIENCE EDUCATION.

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Variability Among the Books

For presentation to this group, variability among the readers has been emphasized. Variability among the books will be presented briefly.

With regard to amount of space bracketed, variation was significant among subject matter fields—general science, biology, physics, and chemistry—and also among other undisclosed book characters. If the variation from field to field were purposeful, it would seem to require justification; however, it may well have been unintentional.

Since the amount of space bracketed depended upon the readers as well as on the books, it is impossible to say what part of their space the textbooks had given to scientific inquiry. Ten per cent was bracketed. If the percentage devoted to scientific inquiry approaches ten per cent, such a value seems inadequate implementation, at least to one who remembers that scientific inquiry—the method and attitudes—constitutes two-thirds of a classic statement of the objectives of science teaching.

A major question in the original plan of the study, what ideas pertinent to scientific inquiry were found in the textbooks, was abandoned because reader variation was confounded with book variation. The determination and criticism of such patterns still seems to be a worthy purpose for future research.

Study of the means used by textbooks in presenting scientific inquiry was abandoned for a similar reason.

CONCLUSION

Scientific inquiry is accepted as an important objective of education. It is hoped that the work just described will assist progress toward the accepted objective.

MATERIALS OF CONSUMER SCIENCE FOR THE JUNIOR HIGH SCHOOL *

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STATEMENT OF THE PROBLEM

THE purpose of this investigation was to select and organize from periodical literature, materials of consumer education suitable for integration into seventh, eighth and/or ninth-grade courses of general science.

The major problem was resolved into four minor problems:

1. To develop criteria for the selection of the materials of consumer education, and to determine the reliability and validity of these criteria.
2. By means of these criteria, to select materials of consumer education; and to organize these materials into topical categories.
3. To evaluate the suitability of materials belonging in these various categories, for integration into seventh, eighth and/or ninth-grade courses of general science.
4. To assign those categories judged to be of value for the intended purpose, to principles of science to the understanding of which they may be expected to contribute, and/or to the scientific attitudes in the development of which they may be deemed likely to assist.

In the reports of these minor problems, that follow, problems 3 and 4 are treated together.

PART I

The development of criteria for selection of the materials of consumer education and the determination of the reliability and validity of these criteria.

STATEMENT OF THE PROBLEM

The purpose of the phase of the investigation here reported was to develop criteria for the selection of materials of consumer education, and to determine the reliability and validity of these criteria.

* This article is the first of a series of two reporting a dissertation for the degree of Doctor of Philosophy at the University of Michigan.

TECHNIQUES EMPLOYED

If the materials of consumer education are to be integrated effectively with the subject-matter now constituting the courses offered in our public schools, it becomes necessary to secure a definition, a set of criteria, or some other designation, which indicates unquestionably what consumer education is.

An examination of the literature in this field revealed that there was as yet no generally accepted concept of consumer education. The definitions were without exception found to be too nebulous and/or too general to serve satisfactorily as a guide to the selection of the subject-matter of consumer education.

A search was therefore made through masters' theses, doctors' dissertations, articles in periodicals, and books for all the definitions and criteria of consumer education they contained. This search brought to light in a study by Klautsch [1] an outline which seemed likely, with necessary modifications and additions, to serve satisfactorily as a set of criteria for selecting materials of consumer education.

The adequacy of Klautsch's outline for the intended purpose was tested by analyzing the materials in four issues each of *Consumers' Guide, Hygeia, Good Housekeeping,* and *Time,* published prior to July, 1945. The entire contents of each of the issues, except advertisements, letters of opinion to the editors, and materials classified in the table of contents as fiction, were carefully read. An attempt was made to identify with one or more of the subheadings of Klautsch's outline, every statement which seemed logically and defensibly assignable to one or more of the major headings. Whenever any portion of such material could not be thus identified, the outline was modified or enlarged sufficiently to enable the identification to be made. The resulting outline, stated in the form of criteria for selecting materials of consumer education, is as follows:

For the purposes of this investigation, an item is considered to be an appropriate part of consumer education if it provides guidance and/or instruction

A. In making a wise choice of goods and services on the basis of
   I Necessity as contrasted with luxury
   II The place of the purchase in the budget
   III Their health values
   IV Other standards of value, than health
B. In deciding efficiently
   I How to buy
   II When to buy
   III Where to buy
C. In using goods and services so as to secure
   I Efficient operation
   II Maximal "life"

It became obvious that this set of criteria could be used effectively only provided that the terms "goods and services" could be satisfactorily defined or delimited.

A further search of the literature revealed Reich's [2] statement that consumer education involves the goods and services in the "basic areas of living." It therefore became necessary to secure or determine a "master list" of these "basic areas of living." Thirteen publications from among those already analyzed were found to yield designations of such "areas."

The process of constructing a master list of mutually exclusive designations from those obtained from these thirteen sources was one of trial and error. Minor aspects were combined to make more and more broad and inclusive designations. For example, "Home Furnishings," "Home Maintenance," and "Home Heating," which had been found respectively in three different sources, were considered to be minor aspects of "Equipment and Maintenance of the Home." Eight designations were thus built up and these included every area named in every source.

This list of eight areas was tested for adequacy by analyzing with it the same materials by the same technique as had

[1] Adolph A. Klautsch, "The Organization, and Administration of Consumer Education." Unpublished doctor's dissertation, University of Illinois, 1943, pp. 24–34.

[2] Edward Reich, "Developing Consumer Education for Individual Needs." *Eastern Commercial Teachers Association, Fourteenth Yearbook,* 1941, p. 205.

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previously been used in testing Klautsch's outline. As this work proceeded it was found desirable to make minor modifications in the wordings in some of the names assigned to the areas.

Table I presents the master list of eight areas together with a designation of the sources in which material related to them appear.

TABLE I

NUMBER OF SOURCES IN WHICH THE BASIC AREAS OF LIVING WERE LISTED OR DISCUSSED *

Basic Areas of Living	Source Number 1	2	3	4	5	6	7	8	9	10	11	12	13	Total Sources
1. Food	*	*	*	*	*	*	*	*	*	*	*	*	*	13
2. The Equipment and Maintenance of the Home	*	*	*	*	*	*	*	*	*	*	*	*	*	13
3. Clothing, Textiles and Clothing Furnishings (jewelry, clothing decorations)	*	*	*	*	*	*	*	*	*	*	*	*	*	13
4. Health and Personal Care (medical and dental care, soap, drugs, cosmetics)	*	*	*	*	*		*	*			*	*	*	10
5. Transportation and Communication				*	*		*	*				*	*	6
6. Leisure and Recreational Activity	*		*	*	*		*	*			*	*	*	9
7. Education		*		*	*		*	*					*	6
8. Savings and Investments (insurance, bank deposits, stocks and bonds)				*			*	*				*	*	5

* Table I is read thus: "Food" was listed or discussed in all of the thirteen sources.

The next step in this investigation was to determine the reliability and validity of the criteria when used for selecting from periodical literature materials dealing with consumer education. It was decided to use repeated and group judgments in determining respectively the reliability and validity of the criteria when actually used in selecting such material. This decision seemed justified in the light of evidence which Keeslar [3] summarizes thus:

"... group judgments are both reliable and valid within the frame of reference set up for them providing (1) that the judges be well-trained and experienced, i.e., *experts* in their fields of specialization and (2) that the criteria in terms of which the judgments are to be made be clearly and concisely stated for that purpose."

Two issues each of *Consumers' Guide* (Oct. and Nov., 1946), *Hygeia* (Nov., 1945, and June, 1946), *Good Housekeeping* (Aug., 1942, and July, 1946), and *Time* (Dec. 16, 1946, and Feb. 3, 1947) were selected at random for the determination of reliability. All the articles in every issue were numbered in ink as a complete and separate set. A total of 306 articles was thus numbered.

Every numbered article in each copy of the magazines was first read and evaluated on the basis of the criteria in order to determine whether that article, or any section of it, dealt with any phase of consumer education. If no part of the article was judged to meet any of the criteria, an *X* was marked under *"No"* on the tabulation sheet. If, however, the article was judged to meet one or more of the criteria, an *X* was marked under *"Yes"* on the tabulation sheet. An *X* was marked also under each criterion which the material was deemed to satisfy and another under each basic area with which the article dealt.

The following is a typical example of these tabulations:

Page	Article No.	No	Yes	A	B	C	1	2	3	4	5	6	7	8
88	67		X	X			X							

[3] Oreon Pierre Keeslar, Contributions of Instructional Films to the Teaching of High School Science. Doctor's Dissertation, University of Michigan, 1945, pp. 104–15. Published in abbreviated form under the title, "Contributions of Instructional Films to the Teaching of High School Science." SCIENCE EDUCATION, XXX (March–April, 1946), 82–8, 132–6.

It is interpreted thus: Article No. 67, on page 88 was deemed to satisfy one of the subdivisions of criterion A, namely "Making a wise choice of goods and services." It was judged to deal with only one of the eight basic areas of living, namely, "Food."

To check the *reliability* of judgment when these criteria and these areas of living were used, the two issues each of the four magazines were analyzed by the investigator on February 16 and 17, 1947, and again on March 17 and 18, 1947. It was assumed that the lapse of one month between the two analyses would eliminate, to a sufficient extent, whatever practice effect there might be.

When both analyses had been completed, a coefficient of correlation was computed between the results by using the tetrachoric diagram method cited by Thurstone.[4] This coefficient of correlation was found to be .93±.02. The S.E. of .02 was computed with Kelly's[5] formula.

[4] Leone Chesire, Milton Saffir and L. L. Thurstone, *Computing Diagrams for the Tetrachoric Correlation Coefficient.* Chicago: The University of Chicago Bookstore, 1933 (unpaged).

[5] Truman L. Kelly, *Statistical Method.* New York: The Macmillan Company, 1923, pp. 256–7.

On the basis of this result, it seems reasonable to assume that the criteria for selecting materials of consumer education from periodical literature have a sufficiently high reliability.

The validity of the criteria when used to select materials for consumer education was then determined. Five advanced graduate students in the School of Education at the University of Michigan carefully examined all the numbered articles in the same magazines used by the investigator in his two analyses and indicated their judgments on tabulation sheets provided.

The designation given each article by a majority of the judges was considered to be the judges' composite designation of that article. A coefficient of correlation was then computed by the tetrachoric method between the judges' composite designations and those given by the investigator in his first analysis of the articles. This coefficient of correlation was found to be .82±.05.

It seems reasonable, then, to assume that the criteria for selecting materials of consumer education from periodical literature have a sufficiently high validity.

WATER LIFE FILMS

LYNE S. METCALFE
New York, New York

A LONG-AWAITED series of discussional-type slidefilms for teaching under water life and for study has been added to its "Science Adventures" series by The Jam Handy Organization.

This series of films is titled "Water Life," and comprises seven slidefilms all in natural color and with labels, letterings and explanatory text for the guidance of instructors and for the benefit of the study group in schools or elsewhere.

While primarily designed to be used for science classes, grades 4, 5, 6, 7 and 8 oral reading classes, grades 4, 5, and 6, biology classes, grades in junior and senior high schools, these films also lend themselves to showings before interested groups in outdoor subjects, the fishing fraternity, and other small group studies.

The seven color films are organized into 24 topics as follows: 1. Life in Ponds, Lakes and Streams; 2. Small Fresh-water Animals and Insects; 3. Fresh-water Shellfish and Amphibians; 4. Fresh-water Turtles and Fish; 5. Keeping an Aquarium; 6. Plants and Strange Animals of the Sea; 7. Shellfish of the Seashore.

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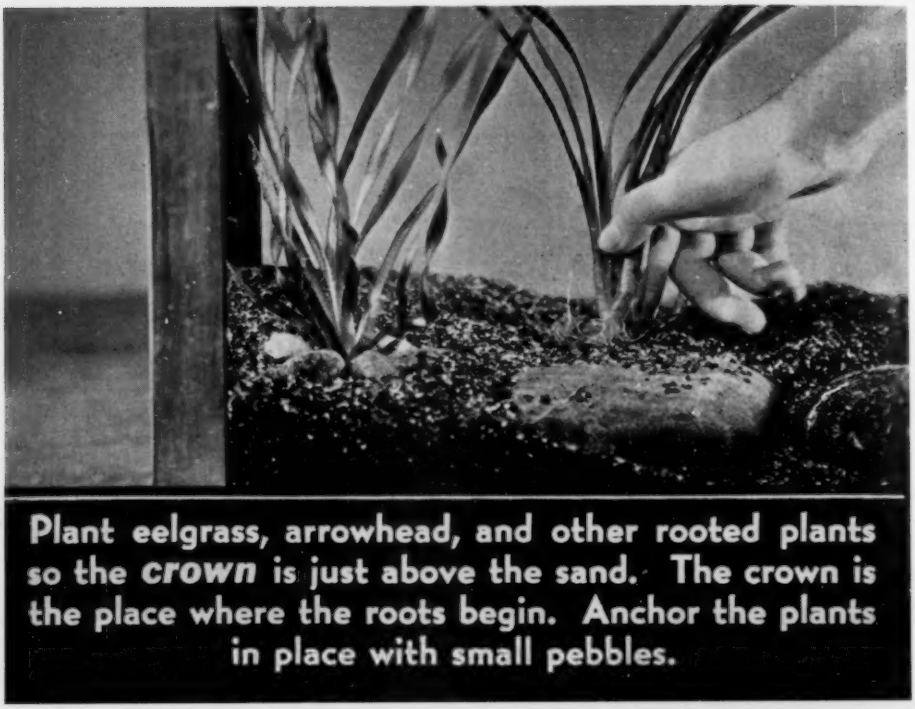
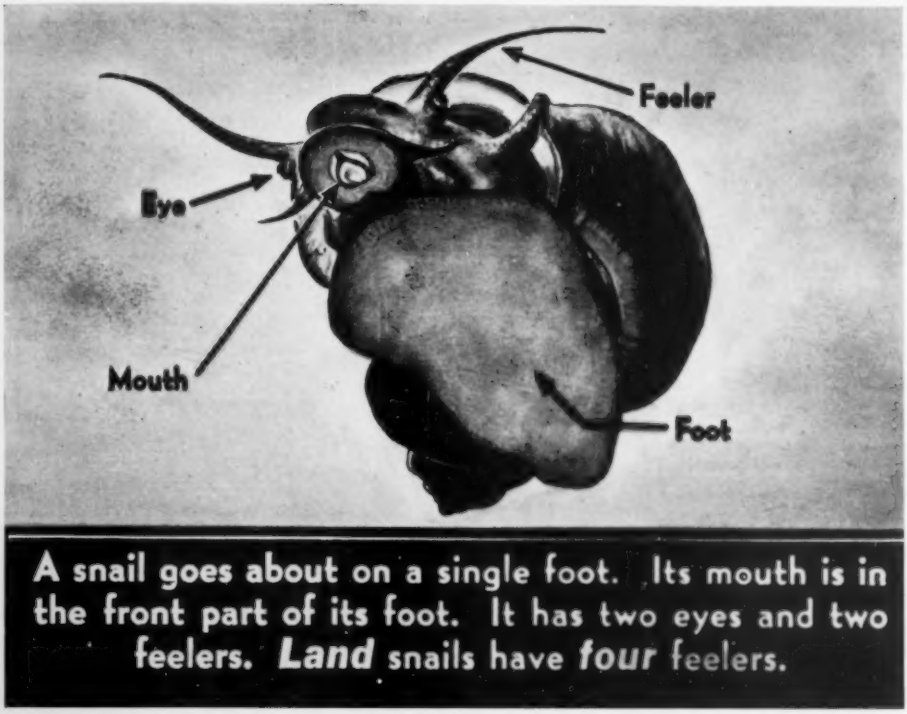

Plant eelgrass, arrowhead, and other rooted plants so the crown is just above the sand. The crown is the place where the roots begin. Anchor the plants in place with small pebbles.

The Jam Handy Organization

The Jam Handy Organization


Feeler
Eye
Mouth
Foot
A snail goes about on a single foot. Its mouth is in the front part of its foot. It has two eyes and two feelers. Land snails have four feelers.

The Jam Handy Organization

CLIMATE OF SÃO PAULO, BRAZIL

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INTRODUCTION

DESCRIPTION and classification of the climates of locations geographically within the tropics, but at some elevation above mean sea level, has been a vexing problem to many climatologists, geographers, and teachers; for application of many of the standard climatic criteria produces erroneous, or even absurd, climatic concepts.

Until quite recently, clarification of this problem has been retarded by lack of data, the meteorological services of the lands in the southern hemisphere being, in general, young in comparison to those in the United States, Canada, and parts of Europe. During the last decade, however, several climatic reports from South America have combined the necessary thoroughness and length of record to permit a rather clear understanding of the tropical high altitude climate.

In this brief paper, the general problem will be illustrated by a comparison of the climate of São Paulo, Brazil, as described in a scholarly and painstaking report by Dr. Ary França;[1] with that of Pine Bluff, Arkansas, a low-level station having the

[1] França, Ary, *Estudo Sôbre o Clima de Bacia de São Paulo*, Universidade de São Paulo, Boletins da Faculdade de Filosofia, Ciências e Letras, LXX, Geografia No. 3, São Paulo, Brasil, 1945.

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same mean temperature and annual precipitation, as indicated by long-term records of the United States Weather Bureau.[2]

SUMMARY GEOGRAPHY

São Paulo is located in the South American republic of Brazil, at Latitude 23° 32′ S.; Longitude 46° 35′ W.; Altitude 2700 feet; approximately. The city is close to the southern escarpment of the Brazilian Highland ("The Coffee Plateau"), which, while constituting a serious transportation barrier, also makes possible hydroelectric development in a land where mineral fuels are scarce (Figures 1 and 2).

Pine Bluff, Arkansas, is a medium-sized city located on the south bank of the Arkansas River, at Latitude 34° 13′ N.; Longitude 92° 01′ W.; Altitude 215 feet;

[2] Contained in monthly and annual *Climatological Data, Arkansas Section,* published by the U. S. Weather Bureau. Some additional information, used in this study, was secured for the writer by Mr. Paul H. Miller, of the Indianapolis Office of the U. S. Weather Bureau.

FIGURE 1. Summary map of South America, showing location of São Paulo.

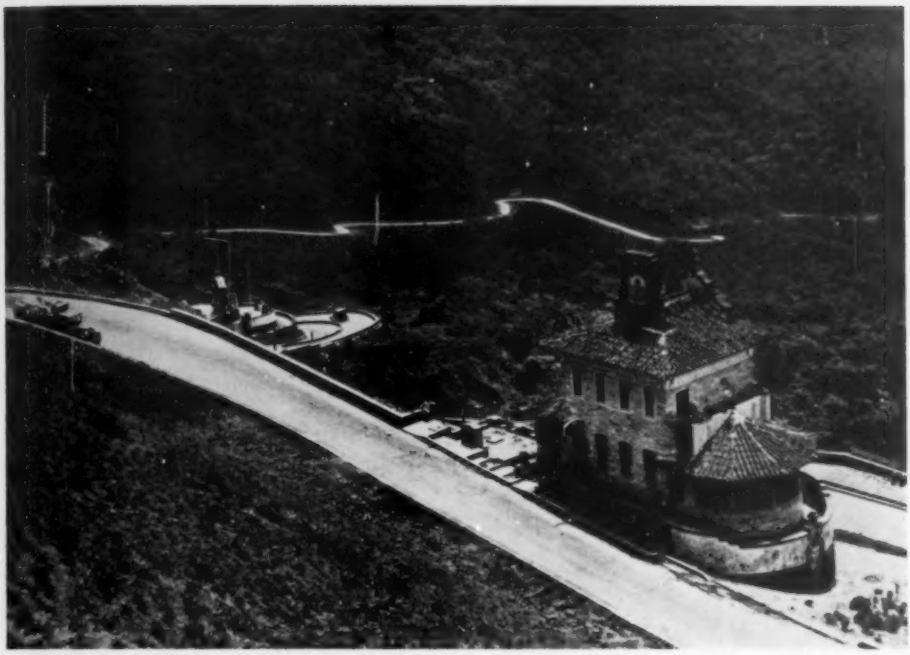

FIGURE 2. A section of the Santos-São Paulo highway where it climbs from sea level toward the summit of the plateau, more than 2,500 feet higher. Photograph from Brazilian Government Trade Bureau.

approximately. The townsite covers a series of bluffs above the river bed.

GROSS CLIMATIC DATA

Reference to the climatic reports of the area shows that São Paulo has a mean annual temperature of 63.7° F., and a total annual rainfall of 53.1 inches. Records of the U. S. Weather Bureau show that Pine Bluff, Arkansas, has a mean annual temperature of 63.1° F., and a total annual rainfall of 51.2 inches. Further search of the records shows that the April and October temperatures are about the same in both places, and that maximum precipitation at both stations occurs in January. On the basis of these, and a few other similarities, by a misapplication of Köppen's methods, many people, including some teachers of Geography, state categorically that the climate of São Paulo is temperate, "just like in the United States". This statement, while most interesting, seems to be slightly inaccurate.[3]

CLIMATIC PATTERNS

When the monthly mean temperatures and rainfalls at São Paulo, as determined by França, are compared with the same figures for Pine Bluff, as shown by Kendrew,[4] it becomes apparent immediately that the climatic patterns are not even similar in the two locations, as should be made clear by Figure 3.

At São Paulo, the warmest months are January, February, and March (the South-

[3] By a similar attention to agreements of evidence, and disregard of negative instances, it can be shown that a turtle resembles a cow quite closely.

[4] Kendrew's figures, which are in close accord with those of the U. S. Weather Bureau, are used here to facilitate comparison over wide areas. See Kendrew, W. G., *The Climates of the Continents*, Oxford, 1937.

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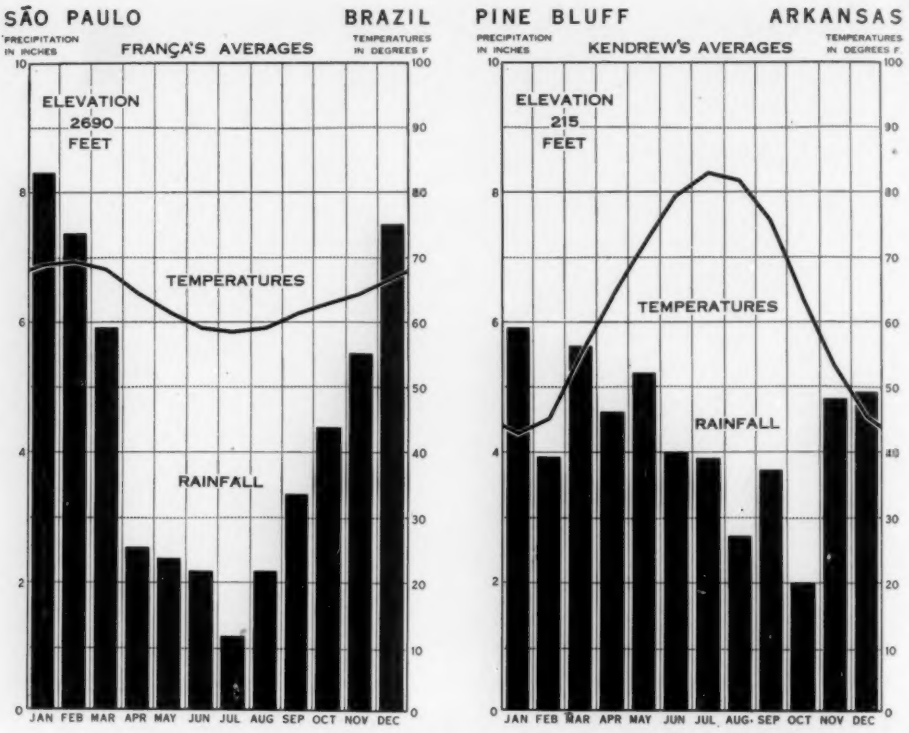

FIGURE 3. Climatic charts for São Paulo, Brazil, and Pine Bluff, Arkansas.

ern Hemisphere summer months). Maximum precipitation occurs during the season of maximum insolation; and drought prevails during the season of minimum insolation (June, July, and August, the Southern Hemisphere winter). Definite seasonal distribution of rainfall, with the annual rainfall cycle approximately in phase with the annual temperature cycle, is apparent here. This pattern is characteristic of tropical savannah climates.

At Pine Bluff, the warmest months are June, July, and August (the Northern Hemisphere summer). Maximum precipitation occurs during November, December, and January, the quarter of least insolation. Minimum precipitation occurs during the period of declining insolation —August, September, and October. Seasonal rainfall distribution is not in any simple pattern, suggesting a somewhat complex air—mass regime. Maximum of the rainfall cycle is about 180° out of phase with the temperature cycle, but the "wave form" is definitely asymmetrical. This general climatic pattern is common in the south—central United States.

SECONDARY AND DERIVED CLIMATIC DATA

Although most systems of climatology depend solely upon rainfall and temperature data, these being the most available figures, other weather information, when available, is most useful. Some of these data can be derived by mathematical methods from observed rainfall and temperatures; others require separate instrumental observations.

Much additional useful and interesting information for the São Paulo area is contained in França's report. Similar data for Pine Bluff were supplied by the U. S.

Weather Bureau. Parallel charts, showing mean relative humidity; monthly index of aridity;[5] percent possible sunshine; and mean monthly temperature range (the average of the daily ranges during the month), comprise Figure 4.

Reference to this chart shows that the mean relative humidity at São Paulo is higher at all seasons than that at Pine Bluff. Were the summer temperature at São Paulo as high as that at Pine Bluff, São Paulo summers would be well-nigh intolerable. The same would be the case were the summer relative humidity at Pine Bluff as high as that at São Paulo.

Direct sunshine at São Paulo reaches its maximum percentage during the winter, which is also the dry season, both as to rainfall and to relative humidity. Pine Bluff, in contrast, has maximum sunshine during the summer, a condition favoring agriculture, and the air-conditioning industry.

São Paulo has a winter drought, whereas the dry season at Pine Bluff comes toward the end of the summer—a condition which is most favorable to agriculture when it comes during harvest season, but most unfavorable if it comes just a few weeks early, at the end of the growing season.

Mean monthly temperature ranges (the means of the daily ranges during the month) are similar at both stations, and within the range of values that are usually classed as "stimulating" (about 15°–25° F.). Annual range at São Paulo is about 11.2° F., which is characteristic of areas near the equator, whereas that of Pine

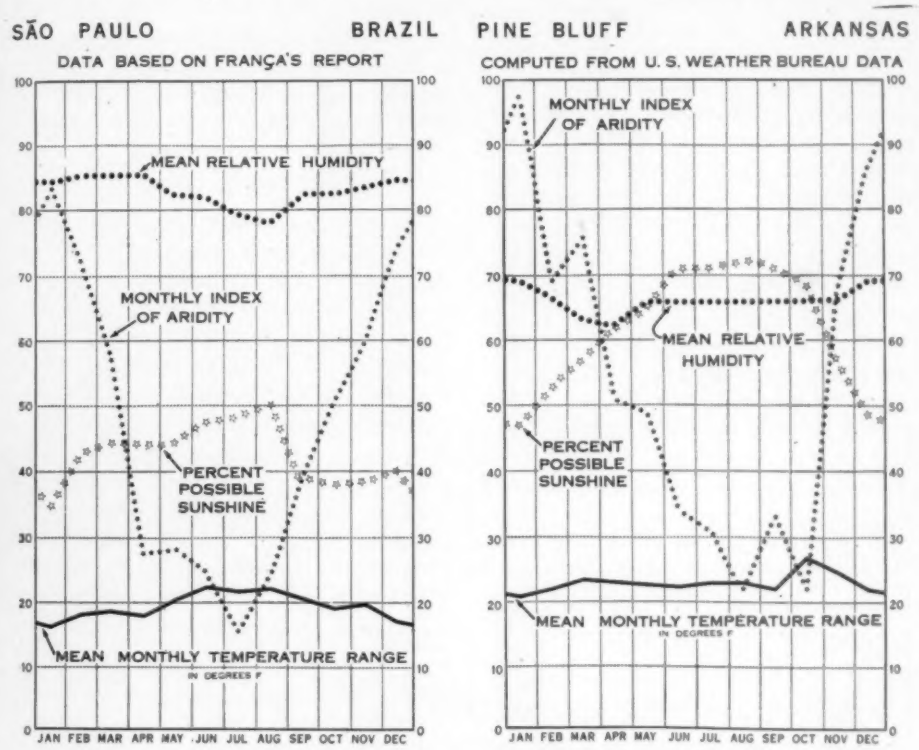
SÃO PAULO BRAZIL
DATA BASED ON FRANÇA'S REPORT
MEAN RELATIVE HUMIDITY
MONTHLY INDEX OF ARIDITY
PERCENT POSSIBLE SUNSHINE
MEAN MONTHLY TEMPERATURE RANGE
IN DEGREES F
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
PINE BLUFF ARKANSAS
COMPUTED FROM U. S. WEATHER BUREAU DATA
MONTHLY INDEX OF ARIDITY
MEAN RELATIVE HUMIDITY
PERCENT POSSIBLE SUNSHINE
MEAN MONTHLY TEMPERATURE RANGE
IN DEGREES F
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

FIGURE 4. Secondary and derived climatic data for São Paulo, Brazil, and Pine Bluff, Arkansas.

[5] This index is computed from De Martonne's formula: Monthly index of aridity = $\frac{12 \times \text{Monthly precipitation in mm.}}{\text{Mean monthly temperature in } ^\circ\text{C.}}$

Bluff is about 39.9° F., a value common at inland stations in the temperate zones.

EFFECT OF ELEVATION

Because of its altitude (about 2690 feet above MSL), coupled with excellent natural drainage and competent city planning, São Paulo is a most healthful city, with a climate that is usually regarded as pleasant and stimulating.

The principal effects of elevation at São Paulo, in addition to making adequate drainage possible, are a lowering of temperature by about 10° F. from the value that it would have at sea level, and a consequent reduction in specific humidity. In contrast, Santos, the seaport for the southern part of the Brazilian Plateau, has a mean annual temperature of about 69° F., even though it is on the seashore, and has removed itself from the "hellhole" classification only by construction of an extensive and costly drainage system.

Annual indices of aridity, by De Martonne's formula, are: 45.5 for São Paulo; 63.9 for Santos; and 49.2 for Pine Bluff. By way of comparison, that for New York City is 50.9.

Further study of the effect of elevation discloses that in most locations the mean annual temperature is reduced about 3° F. by each 1,000 feet of elevation, but the annual distribution of temperature ("pattern") is practically unmodified (see Figure 6).

Because temperatures remain within tolerable ranges at all seasons, the climate of São Paulo has a definite "verano" and "invierno", even in the popular sense, whereas sea level cities colloquially have a "infierno—invierno" sequence, and those at very high altitudes have a "verano—infierno" climate. Although these Spanish plays on words are commonly used in a humorous sense, they are most correctly expressive.

OROGRAPHIC EFFECTS

When air is forced up an incline, as are the southeast winds which blow from the Atlantic Ocean to the summit of the Brazilian upland, it is commoniy cooled by expansion, producing localized increases in precipitation. This is called orographic precipitation, and is an approximate function of the steepness of the slope. As might be expected from the abruptness of the Brazilian escarpment, this produces a marked concentration of rainfall at the eastern rim of the plateau. An effective comparison of rainfall and topographic profiles, based on studies by França, com-

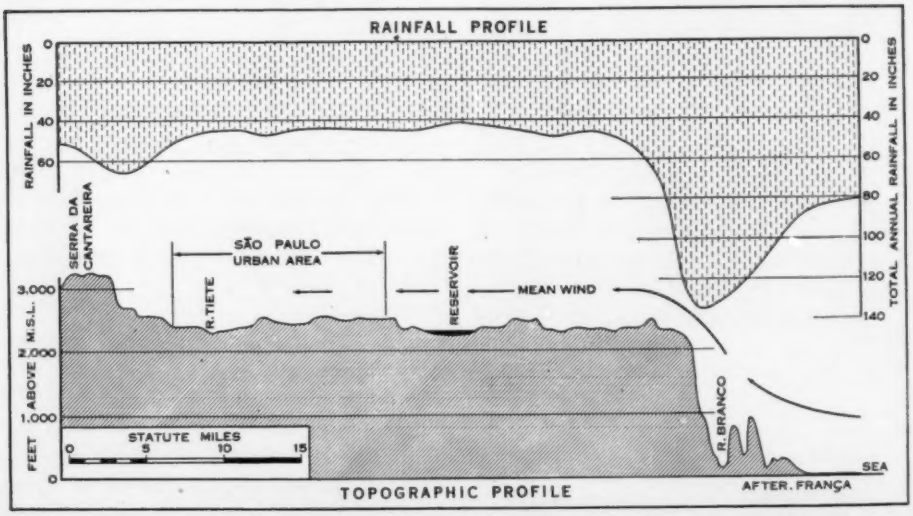

FIGURE 5. Comparison of topographic and rainfall profiles at the edge of the Brazilian plateau. Note here França's effective use of an inverted rainfall profile.

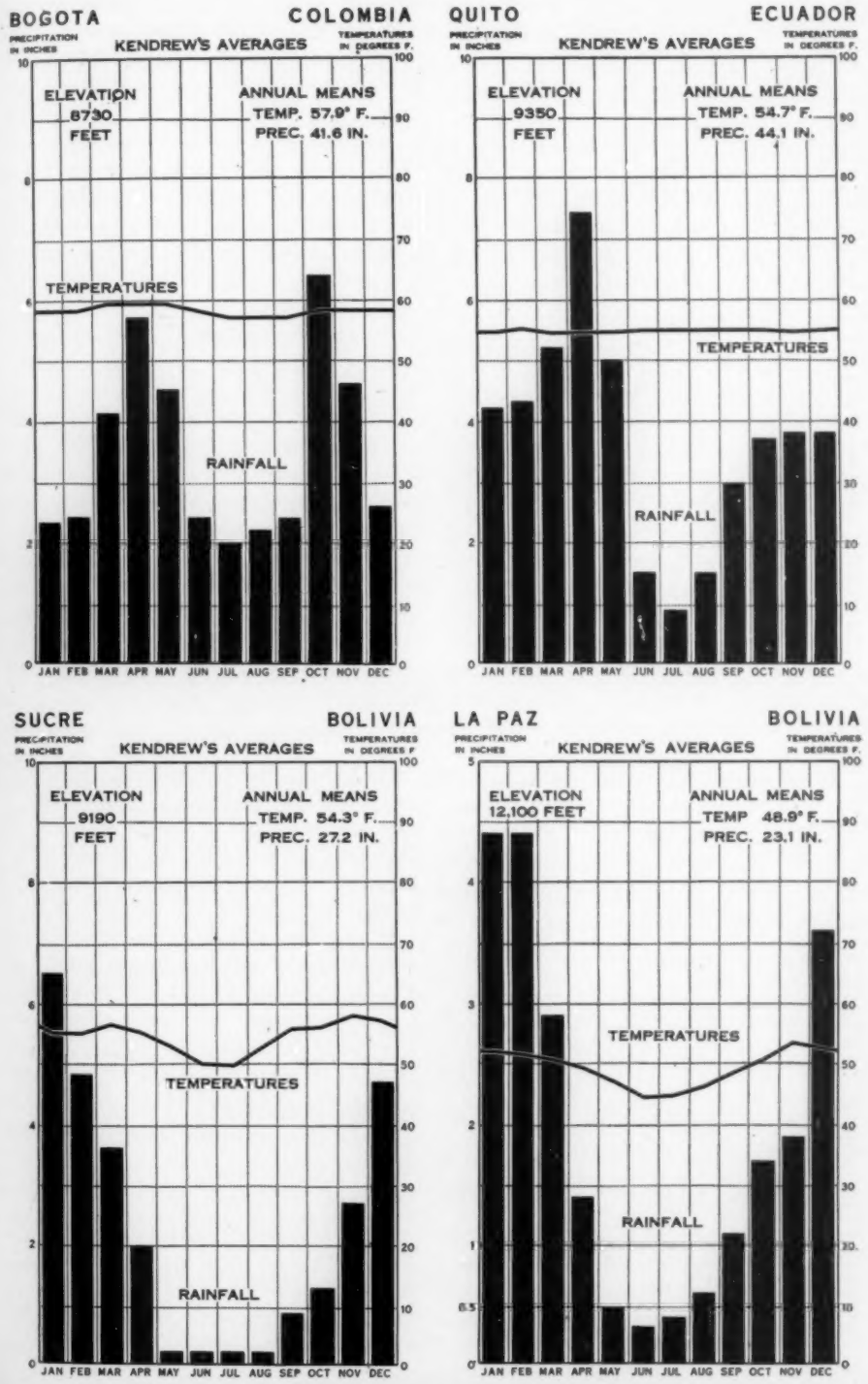

FIGURE 6. Climatic charts for four sample elevated tropical sites.

prises Figure 5. The marked localization of heavy rainfall here makes possible extensive hydro-electric power generation, an important factor in the economy of a coalshy nation.

Away from both the edges of the plateau and from interior highlands, upland rainfall is fairly evenly distributed areally, retains its tropical savannah distribution pattern, and has a smaller amount than at sea level in the same latitude.

TROPICAL HIGHLAND CLIMATES

Extension of the general climatic conclusions reached for São Paulo to other tropical highland areas indicates that, as a general rule, to which exceptions can be found, the climatic effect of an elevated site, not adjacent to a pronounced change in terrain, is to reduce temperature and rainfall, while preserving the general temperature and rainfall distribution patterns common at the latitude concerned.

Although detailed climatic studies are not readily available for all tropical highland cities, even in South America, enough information has been published to permit illustration of this working rule. Climatic charts for Bogota, Colombia; Quito, Ecuador; La Paz, Bolivia; and Sucre, Bolivia (respectively at latitudes 4°36′ N., 0°14′ S., 16°27′ S., and 19°03′ S.), comprising Figure 6, show the effects of elevation on tropical climates quite plainly.

SUMMARY

An abridged description of the climate of São Paulo, Brazil, based on the more extensive work of França, shows plainly that the climate, due largely to elevation, is stimulating and healthful, despite the tropical location. Comparison of this climate with that of Pine Bluff, Arkansas, a temperate zone station having the same annual means of temperature and rainfall, as well as a few other climatic identities, indicates that the two climates are by no means identical, despite the similarities, and that designation of the climate of São Paulo as "temperate", in the ordinary sense of the word, at least, is not justified.

Study of a number of tropical stations, at various elevations above sea level, indicates that the magnitudes of the mean values of temperature and rainfall are definitely modified by elevation, but that the temporal distribution of these climatic factors is changed only slightly. In consequence, the term "Tropical Highland" is suitably descriptive of these climates, whereas the terms "Temperate", or "temperate because of altitude", used today by a few writers and more teachers, are not only unsuitable, but misleading.

ACKNOWLEDGMENT

The writer is indebted to Dr. Ary França, of the University of São Paulo, Brazil, for permission to paraphrase parts of his report on the climate of that area; to various official governmental agencies of Bolivia, Ecuador, Brazil, and Colombia for technical information; and to the U. S. Weather Bureau, Washington and Indianapolis offices, for numerous check observations.

MORE SCIENCE INSTRUCTION?

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ACCORDING to a recent poll of educational *experts* our educational program stands in need of revision if American schools are to meet their post-war challenge. An appeal is made for *more* instruction in science. From another source comes the demand that we make provision for science instruction for all pupils at all levels without regard to prerequisites or to special abilities and aptitudes. Science

must be made the core of the curriculum according to another proponent. *More* science instruction?

A somewhat similar explicit recognition by educators of the need for a thorough survey and revision of the whole ground of education was responsible for the organization, in 1857, of the National Teachers Association (forerunner of the National Education Association). During the following two decades the educational world was thrown into a ferment of discussion by the demand for *more* science instruction in our schools, particularly at the junior-high-school level. *More* science instruction? Why?

By 1857, geography already was being taught in almost all schools, and although natural history was comparatively neglected, natural philosophy, astronomy, botany, chemistry, physiology, geology, and a few other sciences had been introduced into many schools at the junior-high-school level.

In the high schools, which were relatively few in number, physiology, natural philosophy, and either common school geography or physical geography were usually the first-year high school science subjects. Many of the existing high schools offered astronomy, and sometimes botany, natural history, natural theology, hygiene, anatomy, physiology, mineralogy, geology, and zoology at this level.

And the popular policy of the quasi-private schools, which welcomed youths of junior-high-school age who could pay tuition fees, was to teach the science subjects the parents wanted taught, which usually were geography, natural philosophy, astronomy, chemistry, and botany. Why was it that so many persons believed the science education program to be inadequate? Why *more* science instruction?

CRITICISMS AND PROPOSALS

History has its telescopic function in that we learn to see ourselves better by having seen the past as it did not see itself. By the middle of the nineteenth century science was making great advances. In numerous instances science was now leading the way and practice was following, where hitherto, for the most part, inventions and other improvements in the arts of life had set the pace for science to follow. The technological development arising out of scientific theory was in full swing causing a great popular interest in science. The working world began to get loud in its demand for the introduction of the "bread and butter" sciences into the common schools on a much wider scale.

In 1859, Herbert Spencer published his famous essay on "What knowledge is of most worth?" Spencer's answer was "Science." It is science that best prepares a man to preserve his life, earn a livelihood, perform his parental duties, understand society and the ways of social behavior, produce and appreciate art, and develop his intellectual, moral and religious nature. Spencer urged general instruction in science that all might receive training and help in daily duties of life.

In America, Spencer's views were defended by such men as Edward L. Youmans, founder of *Popular Science Monthly*, Francis Wayland, and President F. A. P. Barnard of Columbia University. These men protested vehemently against neglect of the sciences. On the other hand, Thomas Burrowes, long a leader in education in Pennsylvania, and others protested Spencer's utilitarianism.

In the same year that Spencer published his essay (1859), the Reverend Thomas Hill published a plan for science education at all school levels, in Barnard's *American Journal of Education*, which received wide publicity. Hill divided the field of knowledge into five great branches, of which Physics (including Mechanics, Chemistry, and Biology) was one, and it was his belief that "there is no period of a child's life in which he ought not to be receiving direct instruction in at least some of the classes

of study belonging to each of the five great branches.[1]

Hill suggested specific science content under the headings "Mechanics," "Chemistry," and "Biology" for each grade level from kindergarten to college. For the last two years of grammar school and first year of high school, inclusive of ages twelve to fifteen, he proposed the following: *Mechanics:* Elements of Astronomy and Natural Philosophy and Geography (ages 12–13); and a beginning of the Elements of Optics, Acoustics, and Thermotics (ages 13–15). *Chemistry:* Attention called more frequently to chemical changes (ages 12–14); followed by Elements of Chemistry, Electricity and Magnetism (ages 14–15). *Biology:* Elements of Botany, Zoology, Anatomy, and Physiology (ages 12–14); with no biological science in the first year of high school (ages 14–15).[2]

In the same year that Spencer and Hill published their ideas on science education, Louis Agassiz gave an address at the State House in Albany, New York, in which he emphasized the need for the study of Natural History in the common schools. He said:

> I say, therefore, that in our age, when the importance of the study of Natural History is so manifest, by its many implications to the wants of man, I would add that one means of culture to our system of education and add it as soon as possible to educate the teachers who may be capable of imparting the information; and that can be done easily. . . .[3]

Louis Agassiz's ideas were printed in many journals. Many other science educators of the Civil War and post-war periods, such as Asa Gray, James Dwight Dana, and Henry Guyot advocated science education at the junior-high-school level, and were listened to with respect. Although Guyot believed that physical geography belonged to the college level, he realized that so few students would ever attend college, and felt that an introduction to that phase of geography was necessary in the common schools and high schools of America.

By the beginning of the civil war period, some proponents became almost overenthusiastic when science education at the lower levels came up for discussion. To the question "Should Natural Philosophy Be Studied in the Common Schools?" one writer, in 1861, answered:

> Certainly. Shall the children in the Common School learn nothing of weather and wind, of thermometer and barometer, of the phenomena of light and air, of rain and snow, dew and hoarfrost, fog and clouds, lightning and thunder? Shall they remain ignorant of the constituents of food, and of the process of their stomachs and their lungs? Or is it sufficient to read of all this in the Reader? He who answers those questions in the affirmative, is either himself an ignoramus or misanthrope, and he who affirms the last knows nothing of the way in which real knowledge is acquired.[4]

Horace Greeley, America's most famous journalist and moulder of public opinion at the time, in 1864 wrote in the *New York Independent:*

> . . . a reform in our popular education is fundamentally requisite, . . . Into matter and its laws, its transformations and multiform uses, every human being absolutely needs a clear insight. . . . Algebra and Logarithms, Music and Rhetoric, French and Drawing, are all very well in their way; but for ninety-nine of every hundred human beings, a competent knowledge of Chemistry, Geology, and Botany, is far more desirable and important than them all. . . .[5]

It was during the post-war period, however, that the demand for science education

[1] Hill, Rev. Thomas, "The True Order of Studies," Barnard's *American Journal of Education*, 6:185, March, 1859. Hill succeeded Horace Mann as President of Antioch College (1859–62) and preceded Charles W. Eliot as President of Harvard College (1862–68). He went on an expedition to South America with his friend Louis Agassiz.

[2] *Ibid.*, pp. 188–89. A tabular view is given.

[3] "Abstract of An Address on Natural History in Common Schools—By Prof. Agassiz," *Pennsylvania School Journal*, 8:57, August, 1859. Address printed in detail in same journal, 10:314–318, April, 1862.

[4] "Natural Philosophy," *Pennsylvania School Journal*, 10:185, December, 1861.

[5] Greeley, Horace, "The Educational Problem," *Ohio Education Monthly*, 13:68, March, 1864. Reprinting an article appearing in the *New York Independent*. Comments on, and reprints of, this article appeared in other educational magazines.

attracted the greatest attention. James Pyle Wickersham, Principal of the Pennsylvania State Normal School (and soon to become Pennsylvania State Superintendent of Common Schools), in 1866 urged the introduction of more science into the common schools. He said that:

> . . . It is a great mistake to push children into the higher parts of any one study until they have learned the elements of many studies. For example, the principles of Grammar and Arithmetic are studied by many who ought to be studying the elements of the Natural Sciences, . . .[6]

It was proposed that science textbooks be so written as to be suitable for children at lower levels. In 1868, it was proposed:

> . . . Let the attractive features of the science be made prominent, so that while the book is constructed on scientific principles, it shall read like the *talks* of Agassiz. Let the next new edition be not enlarged, but reduced and pruned of all useless matter and form. . . .[7]

W. P. Atkinson, of the Massachusetts Institute of Technology, gave lecture after lecture advocating science education for children under sixteen. In 1870, before the American Institute of Instruction, he said:

> . . . there is one and only one remedy for our present state of educational paralysis, namely, in such a reconstruction of our course of study, from the primary school upwards, through the college and the scientific school, as shall make it one symmetrical whole, based on the two main pillars, first, of a *real* teaching of physical science, begun in the very primary school itself, and with all its earliest stages completed before the age of sixteen; and, secondly, a real training in language and literature, . . .[8]

Joseph White, commenting on science education, at the Institute in 1870, said:

> I am as sick of that kind of object teaching which has been illustrated sometimes at these meetings of the Institute, as Prof. Sanborn said he was; which illustrates objects by holding up a bit of glass, and commenting upon it. No, show simple facts of nature. Let the teachers understand the facts which underlie the great principles of science, but not attempt to teach science from books at first. The young man who teaches a fact in natural history, is teaching his pupils to read, not books, but the Works of God in all His wisdom. If that is the new teaching, let us have it.[9]

Reprints of, and comments on, Horace Greeley's views on science education continued to appear in many contemporary publications. In 1870, Greeley wrote in the *New York Daily Tribune:*

> I hold our average common schools defective, in that they fail to teach geology and chemistry, which in my view are the natural bases of a sound, practical knowledge of things. . . .[10]

In his "Inaugural Address as President of Harvard College (October 19, 1869)," Charles William Eliot proposed that children should study *all* the main fields of knowledge.

> . . . an un-intelligent system of instruction from the primary school through the college, is responsible for the fact that many college graduates have so inadequate a conception of what is meant by scientific observation, reasoning, and proof. It is possible for the young to get actual experience of all the principal methods of thought. . . .
>
> . . . Through all the period of boyhood the school studies should be representative; all the main fields of knowledge should be entered upon. . . .[11]

It was in 1872 that Michael Faraday presented evidence before the Public School Commission in England, and his testimony reprinted and discussed in America, in which he said:

> . . . I never yet found a boy so young as not to be able to understand by simple explanation and to enjoy the point of an experiment. . . .
>
> I could teach a little boy of eleven years old, of ordinary intelligence, all those things in mechanics, hydrostatics, hydraulics, optics, which

[6] Wickersham, James Pyle, *Methods of Instruction.* Philadelphia: J. B. Lippincott and Company, 1866, p. 105.

[7] "Where Lies the Blame," *Pennsylvania School Journal,* 14:59, August, 1868.

[8] Atkinson, W. P., "A General Course of Study," *American Institute of Instruction, Proceedings and Papers,* Worcester, Massachusetts, 1870, p. 78.

[9] *Ibid.,* p. 85.

[10] Greeley, Horace, "Intellect in Agriculture," *Pennsylvania School Journal,* 19:133–134, November, 1870. Citing an article appearing in the *New York Daily Tribune.*

[11] Eliot, Charles William, "Inaugural Address as President of Harvard College (October 19, 1869)," *Educational Reform* (New York: The Century Company, 1898), Chapter I, pp. 3, 12.

are usually taught at a much later period. These subjects, and chemistry and botany, should receive attention in apposite ways and times at school.[12]

The movement to introduce science education into the public schools of America at the lower levels met with opposition, however. Some of the arguments used in the post-war period against science instruction at the lower levels were: (1) Teachers were neglecting the fundamental subjects and the teaching of those who were to leave school early, where the "ologies and osophies" were being taught; (2) Teachers were not prepared to teach the sciences; (3) Suitable science textbooks were not available for use at the lower levels; (4) The minds of the pupils were still too feeble at the common school level to master the sciences; and (5) Children already were studying too many subjects and the tendency was to produce *smatterers*.

There were some who were willing to compromise by accepting science instruction for pupils fourteen years of age or older, but not at lower levels. It was said that "At the age of fourteen, a child will learn more in one month about Geography, Philosophy, Chemistry, etc., than he can learn in one year at the age of ten." [13]

In 1874, a speaker truthfully told the members of the Pennsylvania State Teachers Association:

> The educational world has been thrown into a ferment of discussion, more particularly in the past decade, by the prominence into which the branches of physical science have trust themselves by the wonderful discoveries, and, if possible, still more wonderful practical applications of them. . . .
>
> The earnestness of opinion and purpose is frequently manifested in the temper in which their discussions are conducted. . . .[14]

But many educators were introducing science education into their schools, and believed as John D. Philbrick, former superintendent of the Boston public schools, who, in 1875, told the Department of Superintendence of the National Education Association that "The elements of what is called the *new education*, namely science and art with reference to their application to industrial pursuits, must be included in the modern common-school course." [15]

SUBJECTS AND SUBJECT MATTER

In 1861 Chicago adopted a graded course of instruction written by Superintendent William H. Wells for the elementary schools and in it provided for an oral lesson of fifteen minutes each day on designated material, most of which for the two higher grades consisted of science subject matter. In the second grade (next to highest) of the grammar department, the pupil studied:

> Oral Instruction.—Properties of matter; laws of motion, etc.; physiology and hygiene; morals and manners. The time devoted to oral instruction each week, to be equal in amount to fifteen minutes a day.[16]

A detailed list of topics was provided by Wells for the teacher. For example, the list on properties of matter and laws of motion was as follows:

> . . . General properties of matter—extension, impenetrability, etc. Define and illustrate solids, liquids and gases. Inertia, different kinds of attraction, specific gravity, center of gravity, centripetal and centrifugal forces, flying, swimming, rowing, waterwheels, the action of power in firing a gun, mechanical powers, the pendulum, air—its common properties and uses, pressure of the air, balloons and soap-bubbles, sailing a boat, flying a kite, suction-pump, siphon, barometer, friction.[17]

[12] "Michael Faraday," Barnard's *American Journal of Education*, 1872, XXIII, p. 456.

[13] Holland, J. G., "What Shall Children Study," *Pennsylvania School Journal*, 14:289, June, 1866. Taken from the *Massachusetts Teacher*.

[14] Hines, Charles F., "Natural Science and Popular Education," *Pennsylvania School Journal*, 23:177, December, 1874.

[15] Philbrick, John D., "Can the Elements of Industrial Education be Introduced into the Common Schools?" (Proceedings of the Department of Superintendence of the N. E. A. at Washington, D. C., January 27 and 28, 1875), *Circulars of Information of the Bureau of Education*, No. 1, 1875, p. 86.

[16] Illinois, Chicago Board of Education, *Graded Course of Instruction for the Public Schools of Chicago, July 1, 1862*, p. 59.

[17] *Ibid.*, pp. 59–60.

The first class of the grammar school (highest), in addition to a regular class in geography, had oral lessons in popular astronomy and geology. With some shifting of topics from one grade to another, these oral lessons were taught for several decades in the Chicago grammar department. The first year of the Chicago High School (and the "High School Class" of a similar level located in the elementary schools), offered science, usually physiology and physical geography, although at various times natural philosophy, zoology (or natural history), botany and geography were offered.

Throughout the war period science subjects were offered in the common schools at the junior-high-school level. To what extent is difficult to determine, but in 1864 it was said:

> . . . It is not a difficult matter to find within a few miles of us any amount of schools, where pupils of the age of ten and twelve years are pursuing, and encouraged to pursue, by misguided parents and ill-advising teachers, the study, or more probably the perusal, of from six to eight branches at the same time, when but three or four in the same day would be sufficient to properly consume their time for study. It is not a rare occurrence to meet with pupils of similar age, pursuing the study of . . . perhaps Chemistry, Botany, Astronomy, or some of the other *natural sciences*, when perhaps at the same time, they are utterly ignorant of the first principles of Arithmetic, Grammar, or Geography.[18]

In March, 1867, William T. Harris, in his first report as assistant-superintendent of the St. Louis public schools, stated that he favored the inclusion of science material in reading books; that he desired that mathematical and physical geography be taught in the higher grades of the common schools, but subordinated to political geography. A few months later he became superintendent and in his first Annual Report expressed his viewpoint thus:

> The fundamental studies—the bases of education—undoubtedly must begin thus: I. Reading, Writing, Arithmetic, Geography, Grammar, and History. II. Algebra and Geometry, the study of Latin, German or French, Natural Philosophy (physics)—these come next. III. Afterwards special sciences—such as Chemistry, Physiology, Geology, Botany, Astronomy—the higher Mathematics, Greek, Literature, Mental and Moral Philosophy, Aesthetics.[19]

Harris admits in his 1868–1869 report that he was being asked: "Why do you exclude the natural sciences from your District Schools?" [20] He goes to great length to answer the question, but his answer is implied in one sentence: "Are not reading, writing, arithmetic, and geography necessary requirements for him who would successfully prosecute natural philosophy and physical geography, chemistry, and astronomy?" [21]

Harris's viewpoint was that "it is more important for man to know human nature than material nature. But it is not necessary for him to be ignorant of either." [22] He believed that science is an important study but because man cannot by his own inward efforts supply his wants, but can supply them only through his relationship with others as a social group, it is these social relationships that must take first place.

The study of natural science was introduced into the St. Louis schools in 1871 based on a cycle, or spiral, plan formulated by Harris. Topics were repeated in such a way that any pupil remaining in the St. Louis system for any three consecutive years with passing work would know something of each of the three great departments of science (nature).

In Harris's curriculum, the subject matter provided for the seventh year was taken from the fields of geology, meteorology, botany, and zoology; and for the eighth year from the fields of meteorology and natural philosophy. The grammar-school lessons were confined to one lesson each week, one hour being set apart each Wednesday afternoon but sufficient time

[18] Raub, A. N., "Impatience," *Pennsylvania School Journal*, 12:367, June, 1864.

[19] Missouri, St. Louis Public Schools, *Fourteenth Annual Report (1867–1868)*, p. 95.

[20] Missouri, St. Louis Public Schools, *Fifteenth Annual Report (1868–1869)*, p. 109.

[21] *Loc. cit.*

[22] *Ibid.*, p. 111.

was to be given to each lesson to "allow a deep and lasting impression to be made." Physical geography had been for several years a required subject in the last half of the first year of the St. Louis high school course, and for the time being it continued to be the science subject taught at this level.[23]

In 1872, Illinois passed "An Act to establish and maintain a system of Free schools," in which section 50 said, in part:

> No teacher shall be authorized to teach a common school under the provisions of this act, who is not . . . qualified to teach . . . modern geography, the elements of the natural sciences, . . . physiology, and the laws of health. . . .[24]

The elements of the various sciences continued to be taught in the common schools. A plan often used was to devote a short period each day, usually about fifteen minutes, to science material by way of oral lessons. In many schools, a book on the question and answer type was being used. Two books in use were Peterson's *Familiar Science* and *The Reason Why* volume called *General Science*. Although many students in the upper grades of the district and grammar schools may have been getting only a smattering of knowledge, many no doubt took advantage of their opportunity to learn scientific facts and principles.

By 1876, the subjects offered in the first year of the high schools, which now were more numerous, were usually physiology or physical geography. Often these subjects were required for one term each and then offered together for a third term. Botany sometimes was offered as a substitute or elective science, and sometimes zoology, geography, or natural philosophy were first year courses.

[23] *See* Missouri, St. Louis Public Schools, *Nineteenth Annual Report (1872–1873)*, Appendix, pp. cxi ff., for a description of the Harris curriculum.

[24] Illinois. *Free School Law of Illinois. An Act to establish and maintain a system of Free Schools, approved April 1, 1872—In force, July 1, 1872*, p. 23.

Oral teaching was the method that dominated the period. It was a Pestalozzian form of instruction which called for observation, reasoning, and self-expression. Illustrations were to be used as often as practicable. The child was being encouraged to investigate for himself, form his own opinions, and express them in his own words. It was to be a process of self-development. Emphasis was placed on the descriptive side. The blackboard continued to be used, and the topical method of recitation was generally admitted as being superior.

Teachers in some schools now began to introduce laboratory instruction where the pupils performed the experiments. Aurner tells of a school in Iowa, in 1870, where "It was considered a noteworthy achievement when Jennie Bartlett, thirteen years of age, demonstrated a series of experiments in the determination of specific gravity."[25] Aurner, however, goes on to cite several schools in Iowa where the new laboratory method had been introduced by the early 1870s. Mental discipline was, by 1876, the controlling objective of science education.

A NATIONAL DELIBERATIVE BODY REPORTS

The National Education Association appointed a committee on "A Course of Study from Primary School to University" consisting of William T. Harris, William F. Phelps, and Eli T. Tappan. With Harris as chairman, the committee made its report in 1876, offering its conception of a revised educational program.

The course of study recommended was to fall under five sub-divisions: (1) Inorganic Nature; (2) Organic Nature; (3) Theoretical Man; (4) Practical Man; and (5) Aesthetic Man. All five of these divisions were to be studied at all ages,

[25] Aurner, Clarence Ray, *History of Education in Iowa* (Iowa City, Iowa: State Historical Society of Iowa, 1915), III, p. 427. Citing *The School Laboratory of Physical Science*, Iowa City, I, pp. 24–25.

and the first two of the recommended fields were science fields. Thus the committee clearly brought out in the report that *all children should study some phase of science at all levels.*

For the study of inorganic nature, the district school would provide oral lessons in natural philosophy, and the high school would offer courses in natural philosophy and chemistry. For the study of organic nature, the district school would provide oral lessons in natural history and the children would also study geography, and the high school would offer courses in physical geography, astronomy (descriptive), botany or zoology, and physiology. The grade level for the high school subjects were not given, but from Harris's own program at St. Louis we might assume that he would favor either physical geography or physiology, or both, for the first year of high school.

To those who were critical because language in general furnished so large a portion of the course of study, the committee pointed out: "If thought—scientific thought—be the end of culture and education, it is not strange after all that so much is made of the word that expresses it." [26]

To those who were critical because science education was recommended for younger children, the committee answered:

> To those who object to the study of topics that are too difficult to be understood in the most comprehensive sense until the close of one's disciplinary course it is sufficient to point out the fact that every subject has its abstruse side and that no phase of natural or human history can be completely comprehended except in and through the world itself. Even the disciplinary studies themselves treat of topics that are not fully explicable until one has mastered the other studies.
>
> The child seizes whatever subject he studies more vaguely than the adult. His active phantasy is his child organ. Hence the descriptive phases of science can and should be learned early. In secondary education, the classifications and relations come properly to be considered—reflection is then the chief mental activity.[27]

While men might differ as to what knowledge was of most worth, that of human nature or that of material nature, they began to agree that there is no reason why it is necessary to be ignorant of either. And since complete comprehension of the various phases of human and natural history may be had only in and through the world itself, let the descriptive phases of science which can be learned early be offered to all children at lower levels. This meant *more* science instruction both by quantitative and qualitative estimates.

This increase in science instruction was approved in 1876 by *a national deliberative body* which included in its report recommendations for science education at the junior-high-school level. Since 1859 science has been elevated to a place of great dignity in the schools of America, due basically to changes in the economic ways of our society, and to science itself, but credit should be given to those who were interpreters of social change, and who educated the public to the need for more science instruction.

SCIENCE IN GENERAL EDUCATION

Again, following a great war, we are concerned with the place of science in general education. Once again science is bringing about a great social change. This time men are beginning to doubt whether they are safe from each other. Education must be concerned with the nature of man but complete understanding of human nature continues to be dependent upon an understanding of the world itself. So there is a demand for *more* science instruction.

We are told that it is not enough that courses in science provide precise information, use mathematical methods, and maintain laboratories,[28] but that boys and

[26] National Education Association, Committee Report, "A Course of Study from Primary School to University," *National Education Association, Journal of Proceedings and Addresses,* 1876, XVI, p. 64.

[27] *Ibid.,* p. 65.

[28] *See* the Report of the Harvard Committee, *General Education in a Free Society,* 1945, pp. 150–160.

girls have certain concerns and problems which are common to all and which should be pursued and solved through opportunities provided by means of science education. It is said that we must extend and enrich the background of facts, concepts, and principles in the field of natural phenomena, and develop and vitalize understandings, attitudes and habits which are important in dealing with natural phenomena. It appears to be accepted that we should give increased attention to the scientific method of thinking and problem-solving, and to scientific principles and practical applications which have special interest and value for the individual.[29]

It is claimed that we should undertake to acquaint students with the nature and requirements of scientific occupations, show them the uses of science in other occupations, and acquaint them with the lives of great scientists.[30] Is there any question but that all this will make necessary *more* science instruction in our schools?

Perhaps equally inadequate at present is the time devoted to the social studies, to English, music, art, physical education, and so on. There continues to be some doubt as to what knowledge is of most worth; what knowledge is most effective in bringing our common sense up-to-date. Both the sciences and the humanities are necessary in a complete and general education. Let us not demand so much time for science instruction as to necessitate a decrease in the effectiveness of instruction in other equally valuable fields.

But there is much dead material that may be eliminated. It is satisfactory to all to have the word "more" point to thoughtful revision, reorganization, administration and supervision; to improved methods of instruction. Let us demand new live courses that have direct bearing on present and future problems substituted for some of our present offerings, and real guidance with respect to individual differences in the selection of science subjects continued open to election.

[29] *See* National Education Association, *Proposals for Public Education in Postwar America*, April, 1944, p. 10.

[30] *See* N. E. A. Educational Policies Commission, *Education for ALL American Youth*, 1944, pp. 45, 53, 130–133, 139–140, and 270.

SCIENCE AND THE MULTI-SENSORY METHOD

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THE current emphasis on Audio-Visual Materials and Methods in teaching has impressed some educators as a novel idea; as though it were a new discovery in education. Actually all that is new is the application of sound educational principles to what has often been a "frill." Movie day and Radio time have grown up and are now part of a broader, more intelligent use of all sorts of multi-sensory experiences in learning.

I like to think that science teachers have been sometimes somewhat ahead of others in recognizing the broader values in the Audio-Visual Method. After all, science deals with real things so the "new" ideas about dealing with reality cannot be new to a science teacher. They have been using laboratory methods in which children actually work with the things they learn about. They have used charts, models, specimens, demonstrations, drawings, pictures—all the items so much in vogue these days—for years before the current emphasis began.

Yet it seems there is a place for some re-evaluation of our methods. Not all science is taught in the multi-sensory way. There are all too many class rooms in which a few periods a week with a science

text book passes for science education. Too often it is just more reading lessons with science as the subject.

Perhaps the readers of this magazine are not the persons to whom this should be addressed, for I am rather sure they recognize what good education is. Yet these same readers can assume the responsibility for spreading the multi-sensory point of view among all the teachers with whom they deal.

Just what is multi-sensory education? It is learning which comes through stimulation of as many of the senses as possible—sight, hearing, smell, taste, touch and even the sixth sense if you please, for intuition does sometimes work.

How is the point of view put into practice? By beginning with real things or reasonable facsimiles thereof wherever possible. For instance:—

Every year thousands of children learn about insects. But do these studies begin with real insects or just because some book happened to deal with them? And if they did begin with something the children brought in, what next? Do the children go out on nature walks to observe insects, both beneficial and harmful? Do they organize "Small Game Hunts" and collect insects? Do they arrange, mount and preserve insects? Do they keep *live* insect zoos? Ant houses? Silk worms? Bees? Does their study go beyond the emotional, sugary old time nature study point of view so that children see the relations of insects to the world and to man? Then having dealt with the *real* thing do they add to their knowledge by using books? For I certainly have nothing against books. My only plea is that they be used in their proper place and time. Too often we start with books and then look around for some real examples of the things we read about;

Geographical Terrain Model—Still Life Table Top Photo

or else we make the learnings all vicarious. Insects was purposely selected as an example because most teachers probably do work on such a topic rather purposefully and should therefore be able to carry some of the implications to other work.

In science is it no trouble at all to begin with real things if we are dealing with children instead of being slaves to books. I am rather sure that there was not a teacher in the country this past fall whose children did not bring in leaves, stones, insects, seeds, flowers, magnets, chemistry sets, and all the other odds and ends which so intrigue them. But did all the teachers seek to find out what the children wished to know about these things, or were they just subjects for a brief sharing period, or possibly discouraged entirely because they did not fit in with the rigid plans already made? I have an idea that many special science teachers are more guilty of this than regular classroom teachers if they become bound by outlines and schedules with no regard for children's interests.

Most teachers do an honest job of planning for children's needs as they see them, but children's interests are a little harder to allow for. I am not saying we must be at the mercy of every child's flight of fancy. A basic science education requires a broader plan than would emerge from children's interests alone. After all, children only know about the things with which they have already had some experience. Teachers must be leaders and guides. It is our job to take them on from where they are. But the principles discussed above need to be constantly applied. Are the things we deal with real? Do they really concern children? What real experiences are they having? Are we trying to *teach* concepts and abstractions or are the chil-

Trip to the Lagoons—Geology Field Trip

Eighth Graders Make a Model of the Earth

dren developing these from real experiences of their own?

The fields of science are rich with multi-sensory experiences whether we deal with elementary school children being introduced to science or with older folks in specialized training. But creative imagination and some ingenuity come in handy. Are you studying the solar system? Make a miniature one. Learning about the moon? Model its surface or chart its phases from direct observation. Geography? How about a terrain model which will show the relationship of geographical terms? Volcanoes? Make one that really works. Geology? Take a trip in your own community and its environs and see what kind you have right at home. Electricity? Use batteries, generators, motors, switches, read meters, compute bills, figure costs, visit a power plant. We could go on and on ——.

There was a time when Audio-Visual Education meant simply getting movies or radio programs that dealt with the subject under consideration. Now these aids are only one part of the method. Some folks even go so far as to frown on their use when the real thing is available, as for instance movies about leaves instead of study of the real leaves. Neither should movies and radio be used if they do no more than entertain. But, properly correlated, they can be very valuable in providing visual and auditory contacts with the subjects being studied.

Perhaps the gist of this whole article is simply this: multi-sensory aids should not be substitutes for real experience, they should *be* the experience.

SAFETY IN SCIENCE TEACHING

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THE backbone of science education is experimentation and project work involving manipulation of laboratory equipment, chemicals, and other materials. Unfortunately some people avoid accidents by avoiding the handling of materials and thereby avoid effective science teaching. Undoubtedly the handling of science equipment demands planned care in order to avoid accidents. We science teachers go on the theory that avoidance of accidents in the science laboratory can be achieved by taking reasonable precautions *and* by teaching safety. Planning along these lines involves science chairmen, laboratory assistants, science teachers, and pupils.

Science chairmen are directed to make all science teachers and laboratory assistants aware of the hazards in science instruction and stress the seriousness of accidents caused by carelessness, through periodic departmental conferences preferably at the beginning of each school term. Each science chairman is asked to file, for himself and for every teacher and laboratory assistant in his department, a signed statement that a printed set of rules entitled "For Greater Safety in Science Teaching" has been read and its provisions complied with. The science chairman is also obliged to notify the principal of the school, in writing, of any hazards or situations which could cause accidents. Some of these, which might be reported are: defective electrical outlets, gas fixtures, chairs; lack of fire blankets, extinguishers, fire pails and sand; inadequate storage cabinets. He is also obliged to have a first aid cabinet containing the usual materials and two copies of the Red Cross booklet on first aid placed in each science laboratory and preparation room. He is directed to keep combustible and dangerous materials securely locked in a metal cabinet or stone closet, and to see to it that pupils do not handle these materials. He is asked to inspect first aid cabinets, chemical cabinets, and fire extinguishers at least once each term and keep on hand the dates of such inspection. He is obliged to supervise the pupil laboratory service squads to make sure that all pupils on these squads are acquainted with safety rules and regulations and abide by their provisions. Parental consent permitting the use of pupil squad members must be secured in each case. The science chairman is also asked to avoid assigning to science classes teachers who are not qualified to teach that science subject area. The teacher or laboratory assistant is also instructed to perform demonstrations or other experiments prior to the class session in order to test out materials and apparatus and check to see that these work properly.

Science teachers and laboratory assistants are given certain safety directions with respect to pupils. The important directives are: pupils are to be under the direct supervision of a teacher at all times and in all places; they are not to carry dangerous chemicals at any time; they are not to handle materials except under the direction of the teacher; they are not to work with sharp tools unless fully competent; at the beginning of each term they are to be instructed in general safety precautions; and at the beginning of each laboratory period they are to be instructed regarding special dangers. Teachers are also obliged to: report immediately to the principal any injury or accident; be fully acquainted with first aid treatment; notify the chairman or principal of the existence of any hazards; perform classroom experiments only after previous tryout or advice by chairman; exercise special care in handling and storing dangerous chemicals such as acids, corrosive alkalies, and flammable volatile liquids; exercise special

care in disposing of certain chemicals such as phosphorus or acids as waste material.

Pupils, in addition to being instructed in general safety precautions at the beginning of each term and in special precautions at the beginning of each laboratory period, are also taught the following: never to handle apparatus or chemicals without specific previous instruction; to pour liquids from a bottle without spilling the contents on hands or desk; never to pour reagents back into bottles or exchange stoppers of bottles; how to heat test tubes containing liquids; how to dispose of waste material; the location and use of the fire extinguisher and fire blanket; to report at once to the teacher in charge any personal injury sustained no matter how trivial it may appear; to include safety precautions in notebook records.

In this booklet called "For Greater Safety in Science Teaching," published by the New York City Board of Education, are also listed specific safety suggestions for teachers, laboratory assistants, and pupils for each of the science subject areas: general science, biology, chemistry, physics. In this booklet also are listed specific regulations for the storage of combustibles, oxidizing agents, and corrosive materials in the science departments of our schools.

SAFETY IN SCIENCE EDUCATION

Safety in science education can be considered from two main points of view. One is the matter of preventing accidents in school science laboratories and classrooms. The other is concerned with the science curriculum, wherein our objectives include understandings and appreciations of safety which will be carried outside the school.

The curriculum items we take up in our regular science classroom studies and activities cover a wide range of safety education and concern accidents which occur in the home, at play, on the highway, and in industry. By getting them to understand certain scientific principles we hope to condition youngsters to understand the causes of many accidents and to think more about safety.

For example, in studying the force of gravity in our science classes we can explain how the center of gravity is a factor in many accidents. We can explain how a tall floor lamp with a weighted base has a lower center of gravity and is, therefore, less likely to topple over and cause an accident and injury than a tall floor lamp which is not weighted at its bottom. We can explain hazards and stress the careful use of stepladders, stairways, and canoes when teaching about the "center of gravity." We can explain that chairs, boxes and other fragile or unstable objects are not usually safe to stand on.

The important topic of "burning and combustion" lends itself to a thorough safety education treatment. Our students learn about the essential conditions necessary in order for burning to take place: a combustible material, the presence of oxygen, and a suitable kindling temperature. This study of essential conditions for combustion leads logically to ways of extinguishing fires. Students learn how sparks caused by static electricity or from friction of metals can cause fires. The dangers involved in the use of volatile, highly flammable liquids such as gasoline are explained. A mixture of any combustible vapor and air is shown, by actual experimentation under controlled conditions, to be highly explosive. Special precautions in the use and handling of liquids such as gasoline are stressed in our science work. Our students learn that you cannot extinguish oil or grease fires with water. Precautions in connection with the building of fires and the handling of combustible materials are thus made more meaningful. We hope that this knowledge and practice of caution will be applied in their lives outside school.

We believe that realistic experiments, properly safeguarded, on combustibles and

explosives will do more to condition the future actions of pupils than extensive preaching about fire or stressing numerous "don'ts." Our students can understand better the inherent dangers involved in handling fireworks on July 4th or other occasions when they study about oxidizing agents and gunpowder in science classes.

When our students study the velocity, acceleration, and momentum of moving bodies they can readily apply these principles to fast moving automobiles. The principle of inertia when applied to a car moving at a velocity of 60 miles an hour can be demonstrated with telling effect: stopping the car involves time and distance. We can teach them also that an attempt to stop the car too quickly by excessive brake pressure will result in skidding or overturning. We can explain why a driver or his passengers may "go through the windshield" if the car is stopped too abruptly.

In studying about electricity in science classes our students learn about the dangers involved in connection with high voltages, live wires, short circuits, and faulty fuses. We expect our students to refrain from substituting pennies instead of regulation fuses when they understand that a fuse furnishes protection against overloading and short-circuit fires. To one who knows something about electricity, electric cords with their insulation worn off in spots are indicative of danger.

When we study convection currents the students are taught that in a smoke-filled room the safest air to breathe is near the floor. They learn too that smoke and heated air will travel up through elevator shafts and stairways and that a person in an upper floor room of a burning building must exercise caution in opening his door. The need for safety exits, fire drills, and special emergency safeguards is thus impressed upon them.

When they study about carbon monoxide students learn that this poisonous gas is found in automobile exhaust gases, coal gas from furnaces, and in the fuel gas used in kitchen ranges. The knowledge that carbon monoxide gas is odorless and is a cumulative poison no doubt has a salutary effect in avoiding accidents associated with closed garages, faulty control of coal furnaces, and leaking fuel gas lines.

Just a few of the science curriculum areas and topics which have "safety" correlations have been mentioned. There are many more. Enough, however, have been mentioned to show that science teachers can demonstrate to their classes that accidents do not just happen. They are caused—in accordance with known scientific principles and laws—and can be prevented by those who have the understanding and who will exercise reasonable care.

CLARIFYING THE MEANINGS OF TERMS IN THE LIGHT OF MODERN THEORY

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GENERAL chemistry textbooks very frequently confuse the student by not presenting clearly the meanings of certain terms which are used. This comes sometimes from an unwillingness on the part of the author to discard an old idea in favor of one more in keeping with modern thought, and at other times from the notion that by using a term in more than one sense, and thus cutting down the number of terms used, simplification of material will result. The only way to simplify material by using fewer terms is to decrease the number of concepts introduced or to present the concept without introducing a new technical term. Certainly using one word

to mean two or more things adds only to the confusion of the student. Several examples of these two types of errors will be cited using examples from certain general chemistry texts to illustrate the difficulty.

1. *Valence.* There is probably no word used in chemistry that has more different, yet related, meanings attached to it than the word, *valence*. It has traditionally been thought of in a general sense as indicating the combining capacity of an atom. It has, therefore, meant a number, but it has also been used to refer to a kind of bonding when prefixed with ionic, electro-, or co-. Not only has this dual meaning crept in, but more than one set of numbers has arisen.

One text, published in 1947, defines valence as the number of gram atoms of hydrogen or its equivalent that 1 gram atom of a substance combines with or displaces in a given reaction. Here there is no reference to positive or negative numbers and several lines down the page hydrogen is said to have a valence of one and oxygen a valence of two. Two pages further on in the book the reader is told that hydrogen has a positive valence of 1 and oxygen a negative valence of 2 in the compound sulfuric acid. Yet valence has just been defined in terms of the number of gram atoms of hydrogen that will combine or be replaced. A negative number of gram atoms of hydrogen cannot combine with anything.

To make the situation worse, the student is told in the intermediate page between these two statements that . . . a valence bond consists of a pair of electrons and that a sharing of electrons between atoms is called covalence. Here there is no reference to a number when the word, valence, is used. Two pages further on we are told that in the compound acetylene, C_2H_2, we would assume a valence of one for carbon, but that this cannot be true, since no bond would be available to hold the two carbon atoms together. If the student reached any other conclusion than that the valence of C is one in acetylene, according to the definition given, he would be distorting the definition, since it is plain that there is one gram atom of H for each gram atom of C, and the original definition makes no reference to a relationshp between valence and the number of bonds required to "hold the atom together", so to speak.

This text is not alone in its confusing presentation, but it is not possible to present here more than one example.

It seems that it might be too formidable a task to get teachers to substitute new terms for the old ones in certain of the meanings, although a start in that direction has been made by the introduction of the term, *oxidation number*.

Some help can be obtained, however, by presenting the concepts individually rather than all together, and using prefixes and additional words to distinguish between the uses of the word. The student would be introduced to the types of bonding exhibited by different chemical compounds. These types would be designated as "electrovalent" or "ionic" and "covalent." The adjectives with the word "bond" or "linkage" would thus be used. Thus, we would say sodium chloride possesses an ionic or electrovalent bond or is an ionic or electrovalent compound, whereas carbon tetrachloride has covalent bonds or is a covalent compound.

Later in the course, when the student is thoroughly familiar with these bond types, he may be introduced to the term, ionic valence or electrovalence, covalence, and valence number or oxidation number. Note that these are all nouns and will be used to imply number. They might be defined somewhat as follows:

> The *ionic valence* or *electrovalence* of an ion is numerically equal to the number of units of charge on the ion, and is positive for a positive ion and negative for a negative ion. (This definition would include charged radicals as well as simple ions.)
>
> The *covalence* of an atom is the number of electron-pair bonds which an

atom is assumed to share with other atoms in covalent compounds. (This implies only positive covalences, which is correct.)

The *valence number* or *oxidation number* is a number assigned to an atom in any kind of compound for purposes of simplifying the balancing of certain equations, the naming of certain compounds, and the classification of certain reactions. It is assigned according to certain arbitrary but consistent rules. It may be either positive or negative. It bears certain relationships to ionic valence and covalence as the rules indicate. (Then there should follow the familiar rules for assigning these numbers.)

2. *Oxidation-Reduction.* A discussion of valence leads logically to a discussion of oxidation-reduction, for the concept of valence number or oxidation number is most useful in balancing equations involving oxidation and reduction.

Under a section entitled "covalence", a recently published text says, in speaking of those elements in the middle groups in the periodic table, described as somewhat removed from a stable configuration, that loss or gain of electrons to form ions is impossible. An illustration given is that of phosphorus which cannot gain 3 electrons to give a P^{-3} nor can it lose 5 electrons to give P^{+5}. In another chapter in this text the skeleton equation $KMnO_4 + H_2S + HCl \rightarrow KCl + MnCl_2 + H_2O + S$, is given. The reader is told that inspection indicates that the oxidation state of manganese has been changed from $+7$ to $+2$ while sulfur has changed from -2 to 0. There is no objection to this statement in itself, but when the author states that the electron shift in this reaction is limited to phosphorus and sulfur and that each manganese atom gains 5 electrons, changing its positive charge from $+7$ to $+2$, the student who has come to think of "positive charge" as applying to an ion will be somewhat confused. He will recall the inference obtained from an earlier section of the book that ions with even a $+5$ charge do not occur as a result of chemical reactions. How can an electron shift, such as that assumed to occur in this reaction, be confined to the two atoms Mn and S in the light of modern theory? The oxidation state may change from $+7$ to $+2$, but not because a Mn atom gains 5 electrons. The combination of MnO_4^- and 8 HCl might be said to gain 5 electrons.

3. *Molecule.* Any definition is, of course, arbitrary, and the meaning of the word molecule is no exception. One recently publish text introduces the concept of a molecule using "salt" as an example. The continued splitting of a particle of the salt will eventually reach a stage, we are told, in which further splitting will result in two particles neither of which shows the distinguishing characteristics of salt. This particle, which cannot be further divided without losing its identity as salt, is a molecule of salt, according to the author's point of view. But in the section on crystals, the student is told that there are no sodium chloride molecules as such in a crystal of the material. Apparently, here, a "real" molecule is intended to be a particle in which the bonds are covalent. Some chemists would regard an isolated Na^+ and Cl^- as constituting a molecule of sodium chloride, but using this as an illustration of a molecule is confusing to the student in the light of what is said about sodium chloride in the treatment of crystals. Sugar would serve as a better illustration. There is something to be said for each point of view, but a plea for consistency in a given textbook is certainly in order. It might be desirable to point out the different points of view in this case as in others, but let the author adopt one definition and stick to it. It has seemed to me that discussing atoms and then ions and ionic compounds before taking up molecules and covalent compounds helps clarify the matter.

4. *The Atomic Weight.* A newly published text defines isotopes as varieties of

elements with differing weights, but with identical properties, except for those which depend upon weight. Chlorine is cited as an example and is described as consisting ordinarily of two kinds of atoms, one kind weighing 35 and the other kind weighing 37. Up to this point in the text the units used here have not been specified. The student would immediately ask "35 or 37 what?" The author further states that "the apparent atomic weight", experimentally determined, is an average value, but that since the proportions are always the same, the value is constant. The atomic weights of elements are then defined as the weights of individual atoms on the basis of a certain standard, and the atomic weight of oxygen is given as 16. He now gives some meaning to the numbers 35 and 37 given above.

From these statements, one would understand that each isotope of each element has an atomic weight based on the weight of an oxygen atom as 16 units. But there is no mention of the isotopes of oxygen, and whether the standard is defined in terms of one isotope of oxygen or the mixture normally found. Furthermore, the author states in the same paragraph that the atomic weight of chlorine is 35.46. After previous mention of two kinds of chlorine weighing 35 and 37, the student should be thoroughly confused at this point, since he is now told that the atomic weight of chlorine is 35.46. The author is obviously talking here about the "apparent atomic weight" of the previous page.

It would be a simple matter to clarify the presentation of atomic weights. To the chemist, the atomic weight of an element as given in a periodic table and as used in chemical calculations means an average weight of the isotopes in the proportions normally found. This holds true for oxygen also. There is no oxygen atom known that weighs 16 units on the chemists' atomic weight scale, and no chlorine atom known that weighs 35.46. These are average figures. Since chemists' atomic weights are average values for a mixture of isotopes, how can one then use the term "atomic weight" in the usual sense and also use it to refer to the weights of the different isotopes? To be sure, the chemist and the physicist have different scales, the physicist using the lightest isotope of oxygen for his standard of what he calls isotopic weights, but let us not use the two meanings interchangeably.

5. *The Mass Number.* The "mass number" is a term omitted from many general chemistry texts, the term "atomic weight" being used instead. This gives two meanings to the term "atomic weight". Thus we are told in one text that the lithium atom contains three protons which accounts for 3 of its atomic weight units, but that, since the real atomic weight is 7, there must be 4 neutrons in the atom. Thus the author uses the approximate value of the atomic weight—the nearest whole number—to calculate the number of neutrons in the nucleus, with no mention of the fact that this method of calculation gives the number of neutrons in only one kind of lithium. If the atomic weight of chlorine were more than .043 greater than it is, the students, by this method of calculation would be led to postulate a chlorine atom with 19 neutrons in it, but fortunately the atomic weight is just small enough to save him from this error. Also, once the student has been introduced to isotopes the fallacy of this method will be obvious to him. It is true that the method usually gives the accepted structure of the most common isotope, but there is no virtue in learning the structure of this particular isotope rather than that of any other.

The case of bromine is an even better example of the confusion resulting from this method of calculating the number of neutrons in a nucleus. The atomic weight of bromine is 79.916. The atomic number is 35. Using the scheme commonly described in general chemistry texts, the number of neutrons in the nucleus of a

bromine atom would be found to be the difference between 80 and 35, which is 45. There is an isotope of bromine which fits this structure of 35 protons and 45 neutrons, but it is an artificially produced radioactive isotope. The only two known stable isotopes of bromine found in nature are presumed to contain 44 and 46 neutrons respectively. It is obvious that in this case the structures of the naturally occurring isotopes are not obtained when this method of calculation is used.

Would it not be better to introduce the concept of isotopes ahead of, or concurrent with the concept of the structure of the nucleus? The student could be told that istopes of a given element vary in their weights and that this variation is assigned principally to a difference in the number of supposed neutrons in the nucleus. Also he could be told that the sum total of the number of protons and neutrons, called the "mass number", is used to distinguish one isotope from another. Since this number would always be an integer, one does not have to explain away fractional atomic weights in this connection. This would also do away with the very confusing names met in the uranium disintegration series. Instead of being told that U_I (really $^{238}_{92}U$) emits an alpha particle to give U_X, which is not uranium at all, the student would see that, if $^{238}_{92}U$ emits a $^{4}_{2}He$, a $^{234}_{90}Th$ is obviously the atom remaining, and that when this emits a beta particle, $^{234}_{91}Pa$ (not U_{X2}) is the result. There is no virtue in prolonging the use of antiquated designations which were set up when the nature of radioactivity was almost a complete mystery.

After being thus introduced to isotopes and "mass numbers", the student could be given the correct concept of the chemist's atomic weights; namely, that the *atomic weights* of elements are average values of the weights of the atoms in the proportions usually found in nature, and that the unit of weight is one-sixteenth of the average weight of oxygen atoms taken in the usual ratio in which they occur.

If the teacher or author wishes to go further and discuss the values of the atomic weights in terms of nuclear structure, he may take up the proportions in which the isotopes occur and also the packing effect.

6. *Acids and Bases.* I have no brief to make here for any particular definition of acids and bases. I would like, however, to plead for consistency on the part of the author of a text. If he says that he will use one concept let him follow it. This is not to imply that only one concept should be introduced. I believe that there is value in impressing upon the student that a definition is an arbitrary thing and that the opinions of authorities differ, but slipping casually from one point of view to another without proper warning to the student is hardly to be condoned.

Conclusion. These are some of the terms which, in my teaching, I have observed are treated inconsistently in many textbooks. My discovery of one or more of these treatments has led me to abandon a text after a brief trial in the hope of discovering another in which a certain inconsistency is absent. Finding a new one usually leads only to disappointment in the discovery that some other term is inconsistently handled or treated in an outmoded fashion with no apologies on the part of the author.

Certainly the subject of chemistry is difficult enough without making it more so, and certainly we should like to make the concepts as clear as we can in the minds of the students. Let us, therefore, be careful to imply the same meaning when a given term is used throughout a given text, or if this is impossible, then to explain to the student that, unfortunately, more than one meaning has become attached to a given word or phrase.

TERMINAL SCIENCE

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TERMINAL science was developed as the final course in science to be given to those students who planned to go to work immediately upon graduating from high school. After about 20 years of development, the course has assumed a definite form. It is now given to adults as well as to students in high school. Teachers, practical business men, college graduates, men in the trades, and some who have just graduated from high school are found in the adult classes. The content differs so widely from that found in most science courses that all the above-mentioned types of students are approximately on the same grade level.

In the adult classes the formation of the course was almost entirely objective. The subject matter was suggested by the students themselves. The instructors have only subjected the material to the frequency of use test. If topics were suggested which every member of the class used every day, they at once became an important part of the course. Facts and laws which were seldom or never used were replaced with more vital material.

The outline is not a mass of uncorrelated facts. It contains subject matter which men who are in actual contact with the problems of life wish to know. No course of this type can remain static. It must change in accordance with our scientific knowledge and advancement. Teachers who teach objectively always adapt the subject matter to the class before them.

TERMINAL SCIENCE

OUTLINE

The Individual	1. Safety 2. Health 3. Appreciation of environment	
The Home	1. Construction and maintenance 2. Plumbing 3. Heating 4. Air conditioning 5. Electricity in the home 6. Home planning 7. Interior decoration	Construction and use of common tools
The Automobile	1. Construction 2. Operation 3. Care and repair	

HAVE YOU CONSIDERED GEOLOGY—AN IDEAL SUBJECT FOR CURRICULUM ENRICHMENT?

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WITHOUT doubt, one of the most overlooked practical opportunities for improving the curriculum offerings of the secondary school, is in the consideration of geology as a subject matter offering. It would pay huge dividends for every public school educator in America to seriously deliberate on whether or not we can continue to omit geology from our curricula without certain irreparable losses to our future societal masses. No other course can offer such a combination of cultural, functional, practical and interesting materials with carry-over values which will

last throughout the life of the individual. No other course offers such an excellent opportunity to easily blend new values, new intriguing challenges and new practical interest into a dry, uninteresting, outmoded curriculum, wherever such a one exists. No other course can improve citizenship as greatly through understanding and appreciation of the causative factors of the natural features of environment.

In defense of these assertions, an attempt will be made to offer suitable answers to some of the questions which might naturally arise in the thinking of anyone considering the values of geology as a high school subject:

1. What is geology? In many sciences, acceptable exclusive definitions do not exist. However, geology deals with the earth's development; it treats the history of the earth and its modifications; it serves to explain the scenic grandeur of nature's great outdoors.

2. What has been the history of geology as a course in educational institutions? Geology has long been a highly successful college science. For years, it was selected primarily for vocational reasons as the basic training for special fields in mining and related areas. More recently, the course labeled geology in colleges has become extremely popular for meeting the science requirement for graduation. This is largely the result of cognizance of its interesting and practical material. In the secondary field, only a few high schools have offered geology longer than ten years, but within the past two years there has been a gradually increasing interest in adding the course by many of our high schools.

3. How successful has geology been in high schools? By direct report, every high school included in a survey completed by the present writer indicated that geology was considered among the few best courses, if not the most successful course in the curriculum.

4. What are some of the advantages of a course in geology? Geology offers a year of interesting practical study of the earth as a laboratory. It has considerable flexibility in terms of technical or difficult materials. It appeals to many pupils who have little interest in other sciences. It broadens the laboratory science offerings. More especially, it serves as a practical interpretation of natural environment with full appreciation of the grandeur of the great outdoors. It encourages a more wholesome sense of values through a desire to tune one's life into resonance with the great laws of nature. It thus becomes a thoroughly scientific course with opportunities for personal enrichment.

5. Is geology a suitable subject only for mountainous regions or those rich in geological phenomena? While it must be admitted that areas containing interesting geological settings are often considered as more logical situations in which to offer geology, it should be stressed that geology can be effectively offered anywhere. With modern transportation and communication, and with a trend toward world belongingness, our youth of today will in all probability travel extensively. A new perspective for ever-widening world horizons is developed through an appreciation of the scenery and natural resources of other regions. There are unlimited possibilities for making geology realistic even in those areas sometimes considered as isolated from an active but remote world.

6. Are textbooks for a high school geology course available? There are no textbooks available at the moment which satisfactorily meet nearly all of the heavily weighted criteria for selection of a good geology textbook for high schools. There are at least eight textbooks which have been used with some success in high school courses. A recent survey of thirty-six publishers indicated that fourteen of them would like to come out with a high school geology textbook if demand increased sufficiently to justify it. Each of the fourteen indicated that careful consideration had been given to the plausibility of such a text.

It should be admitted that heavy publication schedules and previous commitments during times of printing difficulties will delimit the number of geology textbooks coming off the press during the next three to five years. However, the present textbooks available are quite adequate, and if schools really want geology textbooks in any considerable number, it is logical that companies will soon come forth to supply the expanding market. It is known that there are at least two textbooks which show considerable promise for high school geology now in preparation.

7. What sorts of topics are suitable for content in high school geology? The following topics have been treated successfully in high school geology courses:

vocational and avocational opportunities in geology
sources of materials of geological nature
relationship of geology to other sciences and to the rest of the curriculum
the earth as a laboratory and as a part of the solar system
the chief divisions of geology and related branches
the three great sections of the earth
instability of the earth's crust
earthquakes
volcanoes
the earth's interior
weathering and its effects
the work of running water and streams
great rivers of the world
the work of snow and ice
the ocean and its work
lakes
subsurface water
caverns, sinkholes and caves
the work of the wind
folding and faulting
the nature and occurrence of rocks; their classes
mountains, plateaus and plains
the geology of Canada
the geology of Alaska
the geology of Mexico
our National Parks, their scenery, geology and facilities
the geology of each state in the United States—scenery, ores, minerals, economic products of significance
economic geology and mining geology
strategic and scarce ores and minerals—problems of conservation—shortages and repercussions of short supply
overview of the geology of South America
overview of the geology of Eurasia and Africa
fundamental concepts for basis of historical geology
nature and importance of fossils
geologic time table
hypotheses of earth origin
modern concepts of formation of stars
geology and atomic energy
overview of significant events in each geologic era
climatology of the United States
plant and animal distribution
implications from geology for the future—world geography — reclamation — water development—ever normal supply of strategic materials
an interpretation of the geology of the local region

For laboratory work:

1. mineralogy — classification, identification, uses and importance of 75–100 common minerals.
2. rocks—features, classification, general nature of the important rock masses, structures and varieties; individual work on 75–100 samples.
3. preparation of working models illustrating geological phenomena.
4. individual projects involving collection and classification of personal mineral and rock collections.
5. Field work; geodetic surveys, stratigraphy; map analysis.

It should be admitted that some selection and rearrangement may be advisable and necessary in certain courses.

8. Are laboratory costs and problems difficult to circumvent? Good methodology for laboratory procedures applicable to other science courses are correspondingly appropriate in geology. Geology laboratory can be performed in a room suitable for chemistry laboratory work. Equipment is very inexpensive. Several studies have indicated that the cost of individual pupil equipment will run about a dollar per pupil with a replacement of twenty-five cents per pupil, annually, exclusive of breakage. Adequate rock and mineral specimens normally cost approximately $50.00 at the outset for each 25 pupils. After a short time, replacement becomes less and less, and in addition, the cost can usually be decreased materially through contributions of free rocks and minerals from museums, from state geo-

logical surveys, and by local citizenry. Also many samples can be gathered during field trips and excursions. All of the general significant objectives held for laboratory science can effectively be realized in geology laboratory.

9. What relationship does geology have to other science courses in the secondary curriculum? Geology, physics, chemistry, and biology are all basically inter-related and somewhat inter-dependent. Until recent decades, science was general enough and simple enough so that no division was necessary. Science should be a series of classified knowledges leading to organized common sense. The great orderliness in nature and natural causation through natural laws are intriguing to all men and the sciences fit together systematically to explain or understand these laws. This constitutes an additional reason for not drawing lines sharply between science fields. In the modern curriculum, we are not attempting to build up barriers between sciences but rather we wish to exploit the materials of science, in general, for common learnings and basic understandings which all our pupils should have. Geology offers an excellent body of materials for this sort of treatment. In the general education or core curriculum programs becoming popular in so many of today's schools, geology offers the best possibility as a body of content utilizing science. In addition, the body of materials constituting geology can well be a specialized subject for a full year of science for those who should take it. A survey conducted by the present writer in 1945, revealed that nearly all colleges are willing to accept geology as a high school laboratory science course when it has been offered as a full year laboratory science course. For people planning to major in geology, a good course in high school geology offers excellent background for college geology. The grade placement for geology is not a significant problem. It can blend into the curriculum at any level desired in the secondary school.

10. To which other groups does geology offer excellent possibilities? There are indications that geology will be one of the most popular science courses for terminal curricula in junior colleges. Further, great interest has been shown in geology for adult education classes, and by the populace in general.

11. Is good methodology for geology instruction compatible with good instructional practice for science, in general? The best educational practices for offering geology conform unusually well to the best methods for teaching other subjects. Improved methods serve as encouragement for the pupil and leave a good taste in his academic mouth. Teacher-pupil planning, committee work, lecture-discussion, field work, and workshop techniques all fit nicely into the planning for geology. Geology, properly taught, utilizes effectively a variety of techniques. It also inspires critical thinking and stimulates a quest for further knowledge. Research topics, projects, term papers, thought questions, and a wide reading and browsing practice are encouraged. The criteria of a well conducted class in science are all easily applicable in geology.

12. Will there be an adequate supply of teachers to offer geology? There will not be enough properly trained teachers to offer geology on a widespread scale during the next five years, if too many schools adopt this problem. However, there are hundreds of teachers preparing to teach geology and as interest and opportunity increase, it appears that a sufficient number of teachers will be available. In many instances teacher trainees are being counselled about the possibilities geology as a teaching subject offers.

13. What are some of the other values to consider for high school geology?

a. Geology stresses important lessons toward a wholesome philosophy of life. A study of the eternal work of mountains, rivers, and many other earth fea-

tures serves as a sanifying activity for confused youth.

b. A realization of the pertinence of community resources and problems growing out of them becomes evident.

c. An interest in community assets, an appreciation for or development of a museum and other related civic projects are common possibilities.

d. Knowledge offered by geology has carry-over value into adult life. Appreciations are deeply ingrained both for the physical world and for the importance and dignity of man upon it.

e. Hobbies involving collections of pictures, photography, mineral displays, exchange of minerals with other pupils, and plans for travel grow out of geology.

f. The socializing experience of field trips is of inestimable value. Ingenuity, cooperativeness, responsibleness, dependability, and resourcefulness are prominent features.

g. Field trips develop interest in local and regional phenomena in summer camps, and in pupil exploration.

14. What are some vocational possibilities of geology? For the next decade or two, very few areas offer a richer variety of vocational possibilities than geology. The field for a geologist becomes more significant daily as we run more into strategic shortages of minerals, and as we find new uses of other resources. We shall undoubtedly need thousands of trained geologists to carry on essential work in these areas.

15. Are enrichment materials readily available? There are excellent and ample numbers of reference books and monographs in the field of geology. Over a dozen magazines devote much to materials of interest in geology—in whole or in part. Free and inexpensive materials and pamphlets are available from hundreds of companies. Visual aids materials are plentiful and of high quality. Films, slides, charts, and many other media are abundant. There are dozens of helpful articles in the literature, many of which depict successful exhibits, interesting activities, or better teaching methods.

16. Where do we go from here? It will be well for those interested in improving the curriculum to study the possibilities, consider the problem via committee work, talk to book men, and confer with or write to educators—many of whom are anxious to answer questions about geology as a course for secondary schools. The dawn of a new era for geology is at hand and forward looking educators will plan carefully what part they want to have or how geology can serve their schools. The movement is in high gear and we must consider, institute, evaluate and improve to the end that our high schools will be better off for having added geology to the curriculum. There is no implication in this article that biology, chemistry, physics, or any other science can be accused of failure to fill an important niche in the curriculum. But it is strongly maintained that geology has greater possibilities for contributing richly to pupil growth and development than many other courses and that it can serve uniquely in the modern schools of today.

There are many other questions about geology which might be posed. It will suffice to say that man in a troubled and confused world needs to receive illimitable inspiration from quiet meditation or communion with nature. Through understanding and appreciation of the magnificent beauty provided by natural forces, one can regain a mental composure to face the problems of a complex civilization. Geology sets the stage for this understanding and appreciation. Even the common spring takes on a new entrancing significance when understood through geology. A person thus benefited will not only be grateful for life itself but will receive an upsurge in zestful living toward being a better citizen, a better American, and a better member-participant in the one-world of today.

AN ODOR IDENTIFICATION TEST

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IN the teaching of high school biology, it is common practice to include a unit dealing with the various sense organs and their functions. The test described in this article, emphasizing the special sense of smell, is representative of a type which has been popular with the writer's students over the past several years. This activity follows our study of the nose structure, types and nature of odors, and how we receive and interpret them. The test is in the nature of a reminder of previous odor sensory experiences compounded with those actually present. It has the advantage of allowing the student to exercise his sense of smell and recording his findings.

A wide variety of odorous materials may be used. The list which follows is suggestive. It includes: turpentine, coffee, tea, vanilla extract, perfume, tincture of iodine, moth balls, crushed mint leaf, camphor, cinnamon, nutmeg, oil of cloves, banana oil, apple, orange, lemon, face powder, nail polish remover, shoe polish, and alcohol.

Some points which may be considered when arranging and conducting this test are:

1. Odorous materials which are to be identified may be embedded in cotton and placed within wide mouth bottles. Sufficient time should be allowed for the molecules to permeate the tightly stoppered bottles.

2. Number each bottle. Keep a record of the material within.

3. Work out a system of placing the bottles in a position which causes the least confusion among students.

4. Before beginning the test, make certain each student understands the nature of the test and how it is to be conducted.

5. Each student should have a paper numbered to correspond to the number of items in the test.

6. Begin the test by placing one student before each bottle. All face the same direction. Each advances to the bottle ahead

CHART I

	Boys				Girls			
Odor Tested	Total No. Right	Total % Right	Total No. Wrong	Total % Wrong	Total No. Right	Total % Right	Total No. Wrong	Total % Wrong
Vanilla	.....	.....	.....	.....	.....	.....	.....	.....
Camphor	.....	.....	.....	.....	.....	.....	.....	.....
Coffee	.....	.....	.....	.....	.....	.....	.....	.....
Etc.	.....	.....	.....	.....	.....	.....	.....	.....
Summary	.....	.....	.....	.....	.....	.....	.....	.....

CHART II

	Boys		Girls	
Odor Tested	Items	Excelled	Items	Excelled
Extract of Vanilla.....	.....	.....	.....	.....
Camphor	.....	.....	.....	.....
Coffee	.....	.....	.....	.....
Etc.	.....	.....	.....	.....
Summary	.....	.....	.....	.....

when the signal is given. This procedure eliminates confusion.

7. Allow thirty seconds to remove the cork, sniff odor, record interpretation, and replace cork. The student should understand that if he begins at bottle number ten, his answer must be recorded in space number ten, etc.

8. Insist upon an answer for each item.

9. Allow only one answer per item.

Interest will be added if the test is conducted on a contest basis: Boys vs. Girls. Usually, the number of students involved is too small to form reliable final conclusions. However, the data may be used for comparison of the specific group which took the test. Chart I is used for compiling results.

Chart II is used to record the items in which the boys excelled. Also, those scored highest by the girls. Place an "X" in the proper column.

ANALYSIS OF TEST

1. Were any odors identified by all the students?

2. Were any odors identified by all the boys?

3. Were any odors identified by all the girls?

4. Were any items completely missed by both boys and girls?

5. Were any items completely missed by boys? Girls?

6. In which items did the girls score highest? Lowest?

7. In which items did the boys score highest? Lowest?

THE MEASUREMENT OF STUDENT INSIGHT INTO THE STRUCTURE UNDERLYING THE ORGANIZATION AND VIEWPOINT OF THE BIOLOGICAL SCIENCES

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INSTRUCTORS or staffs charged with the responsibility of devising general courses in the sciences have gradually increased the range of objectives to which they wish to contribute. Emphasis on factual recall has markedly declined, emphasis on broad principles and their application to specific problem situations, and on the methods of problem solving characteristic of the scientific approach has increased. Many ingenious procedures for insuring validity of measurement of student skill in applying generalizations or attacking problem situations in a rigorously scientific manner have been developed.

The staff of the general Biological Sciences course of the College of the University of Chicago have been among those who share willingly in this growing recognition of the complexity of the contribution which science courses may make to student welfare. They have felt, however, that there is an additional major area of insight which a science course should develop in students, not only for the sake of the analytical skills which it implies, but in order that they may more appropriately relate their learnings in the field of Biological Sciences to other aspects of their experience. This area is concerned with the underlying structure by which the body of knowledge customarily assigned to the biological sciences is organized and delimited. It is quite clear that the patterns of classification, for example, used in describing relationships among and within the various phyla, or in ascribing to a particular species membership in one group of organisms rather than another, have been developed because of the purposes of biological scientists, and for their maximum convenience. While these classifications are, in a sense, quite natural, in that they are based on the most objective possible

descriptions of the observable characteristics of organisms, they would not be used if the purpose of observation were very different, and if biological science related itself to other disciplines in different ways. If the sole objective of botanical research were to assist florists to make attractive displays, color might be the basis for classification; landscape gardeners must, in addition to their use of conventional taxonomy for assistance in breeding and other technical problems, also bear in mind an empirical organization of the species known to them based on climatic and soil requirements. Nor need these examples be taken purely from taxonomic fields. In every aspect of the science one finds structures and concepts which are not properly described as *arbitrary* so much as *empirical* —which have been *developed* (rather than *observed*) by Biologists because, in the best Darwinian tradition, biologists find them of adaptive value in their work.

There are, however, numerous courses in biological science in which such structural artifacts are not distinguished from the basic, observable data with which the science deals—in which no effort is made to clarify the difference in *source* of validity between such statements as "glucose is a carbohydrate" and "glucose yields much energy on oxidation in the body". The staff of Biological Sciences in the College of the University of Chicago, feeling it important to help students develop the power to make such distinctions, sought to define precisely, in terms of student skills, some of the component behaviours needed. This was first done at the beginning of the academic year 1946–47. Shortly after the beginning of the next academic year, the statement of objectives adopted for 1946–47 was slightly revised in the light of the recent experience, and the following statement, taken from the "Classification of Objectives of Biological Sciences, as Adopted by the Comprehensive Committee, November 13, 1947," is the most recent commitment of the staff in this matter:

D. Changes in students due to the understanding that science is a man-made structure and to the capacity to identify the assumptions necessary for its dynamics.
   1. Ability to distinguish between technical terminology which adds precision to a text by permitting more appropriate definition of terms, and that which merely replaces a common name by an esoteric one.
   2. Ability to distinguish the referents for words, and to establish the limits within which a biological term may have meaning.
   3. Ability to distinguish symbols which summarize experience, however abstractly (e.g., the laws of heredity), from those which are convenient in classifying, but do not refer to an antecedent reality (e.g., the definition of Coelenterate).
   4. Ability to detect the dependence of certain terms, apparently concrete, on an artificial or arbitrary theoretical structure for meaning.
   5. Ability to distinguish explanations of phenomena from phrases which merely provide technical names for them.

To the author, as Examiner in Biological Sciences, fell the responsibility of devising ways of measuring student achievement of the newly added course objectives. Progress was slow; moreover, the staff wished to limit the proportion of a student's total score based on the achievement of objectives of so novel a character to a small proportion of the total. Area D, as this group was called for convenience, was therefore represented in the Spring, 1947 Comprehensive Examination in biological sciences by a small battery of "one best answer" type multiple choice items, of which the following may be taken as examples:

1. The sea-urchin, an *echinoderm*, and the sea anemone, a *coelenterate*, which commonly inhabit the same tidal pool, are very distantly related animals. It therefore follows that
   A—These two animals cannot really be said to have much in common if looked at scientifically.
   B—There are probably certain fundamental metabolic processes which occur in one of the animals but not in the other.
   C—The two forms could not have had a common ancestor.
   *D—The internal structures of the two organisms probably do not show much homology.
   E—The anemone, as a member of a less specialized phylum, must be regarded as an ancestor of the urchin.

* Indicates answer keyed as correct.

2. When we say that, in the cabbage plant, there is an alternation of sporophyte and gametophyte generations we imply that
   A—Sporophyte cabbage plants and gametophyte cabbage plants could flourish separately from each other, if raised in the field under conditions proper to each.
   B—The gametophyte is produced by modification of a vegetative structure within the sporophyte.
   *C—The entire gametophyte is produced by cell division from a single cell of the sporophyte; the entire sporophyte is produced by cell division from a single zygote.
   D—While cabbage plants cannot grow except through alternation of generations, each generation is an independent plant capable of all essential metabolic processes.
   E—Some cabbage plants produce gametes; other externally similar plants produce spores.
3. A scientist is studying intensively a rare animal about which little is known. Without knowing more about the situation, we can be certain that the scientist will *not* state, as one of his conclusions, that this animal
   A—Has trochophore larvae, with multicolored cilia.
   *B—Came to flourish in order to provide a food supply for larger carnivores.
   C—Descended from forms like the contemporary crocodile.
   D—Is a flying red reptile.
   E—Subsists chiefly on young, tender, fern gametophytes.
4. Even though the common terms suggested to replace the scientific ones in the following passage are not deliberately misleading or actually erroneous, the passage may lose considerable precision of meaning if one of the substitutions is made. Which one?

   The Passage

   "In *Canis vulgaris*, as in other *Eutheria*, the foetus is nourished by absorption of nutrients from the bloodstream of the mother through the placenta, which is formed by the fusion of part of the *chorion* to the uterine wall. While there is thus diffusion of body fluids between parent and embryo, no *erythrocytes* from the bloodstream of the *bitch* pass into the bloodstream of the foetus."

   The Substitutions

   A—For *Canis vulgaris*, dogs.
   B—For *Eutheria*, placental mammals.
   *C—For *chorion*, embryonic membrane.
   D—For *bitch*, female dog.
   E—For *erythrocytes*, red blood cells.
5. The gullet, trichocysts, food and contractile vacuoles, and cilia of a paramecium are called *organelles* rather than *organs*. The best reason for doing this is
   *A—The term *organ* is defined arbitrarily so as to apply only to a structure composed of several associated cellular tissues.
   B—No organism as small as a protozoan can be made up of several cells.
   C—The term *organ* could not be defined so as to include structures consisting only of a part of a cell.
   D—We cannot regard cilia or trichocysts as cells, because they are not separated from the rest of the animal by a membrane.
   E—The term *organelle* merely means "small organ."
6. Which of the following statements would become meaningless or untrue if the organization or viewpoint of Biological Science changed, even though the definition of terms remained the same?
   A—The vessels which carry blood from the heart are arteries.
   *B—The petals of flowers are modified leaves.
   C—Proteins are absolutely essential in the diet of all animals.
   D—The chromosome number of the cells of the gametophyte generation of a fern is half that of the cells of the sporophyte generation.
   E—Sodium cyanide poisons by inactivating an enzyme necessary to respiration in the cell.

The reader should bear in mind that these items are not intended to measure skills in area D apart from knowledge of the conventional content of the College general course in Biological sciences, but rather, in reference to it. Indeed, before editing a Comprehensive Examination at the University of Chicago, a two-dimensional diagram is always laid out, showing course content on one axis and the objectives of the course, defined in terms of student behaviour, on the other. Each item included on the examination must then be assigned to an appropriate square, determined both by its content and by the student behaviour exhibited in responding to it correctly.

Items 1–5 of the examples given above were also included on the Placement Test in Biological Sciences, taken by all high school graduates entering the College in the fall of 1947. While, obviously, none of the students taking the comprehensive in the spring could have been among those taking the placement tests in the fall, the admissions policies of the University had not

changed materially, and there is no reason to doubt that the groups were essentially comparable, except for the possibility that the less able students admitted might never have attempted to pass the comprehensive. This provided a fair opportunity to estimate the contribution of the course, during the academic year 1946–47, to student growth toward objectives of Area D. The following procedure was adopted for the determination.

A random sample of 150 papers was taken from the total group taking the Spring Comprehensive, and a similar sample from the total group taking the placement test. In each case, this sample of 150 represented a total population of the order of magnitude of a thousand individuals. These 150 papers were arranged in descending order on the basis of total score and then separated into a top, middle, and bottom third. The fifty papers in each third were then separately scored, and the number of students obtaining correct answers to each item recorded. The results are presented in Table I:

TABLE I

NUMBER OF STUDENTS, BY QUALITY OF PERFORMANCE ON TOTAL EXAMINATION, SUCCESSFULLY ANSWERING ITEMS MEASURING OBJECTIVES IN AREA "D"

N=50 Students in each subgroup

	Placement Performance			Comprehensive Performance		
Item	H	M	L	H	M	L
1	15	3	5	36	29	19
2	16	6	12	42	32	24
3	30	21	9	44	30	22
4	11	16	7	42	39	34
5	26	14	10	40	41	25

Examination of answer sheets from both examinations establishes that students taking either test showed little tendency to leave questions unanswered. The better performance of students taking the comprehensive was, therefore, due to their greater skill in selecting the right answers. Indeed, on items 1 and 4, placement test students chose response E in preference to the correct answer, while comprehensive students were little tempted by response E in either case. Much better results were obtained on each item by students who had taken the course than by those who had not —and this is true whether high, medium, or low groups of students are compared. The items also appear to serve rather well as discriminators between high, middle, and low goups, of students who have taken the course, except that item 5 discriminated only between low students and all others. For students who have not taken the course, the items also appear to discriminate, but at a much lower level, and with occasional reversals. It seems justifiable to say that the results suggest that students who enter the University of Chicago College possess in some degree the abilities of Area "D", but that they develop them much more fully in taking the course.

Considerably more information, however, is obtainable from a battery of items devised during the summer of 1947, and used in the placement test of that autumn and the comprehensive examination of the following June. This battery is presented below:

There are several kinds of factual statements which may be made about subjects in the biological science field. Some of these are statements of fact, which derive their truth or meaning from scientific observation or experiment, and which must be regarded as true until contradictory evidence is discovered. An example of such a statement is, "Active immunity to smallpox may be produced by vaccination." Another example is, "Smallpox is a contagious disease."

But there are other kinds of statements in the field of biological science which, while regarded as true by some or most biologists, are true only because biologists have chosen to organize their

field of investigation in a particular way, or to interpret it from a particular viewpoint. With a different organization or viewpoint, these statements might become meaningless or untrue, even though no contradictions had been found to the facts which had previously underlain them. An example of such a statement might be: "The head of a daisy is composed of many flowers rather than one," for it is no more a distortion of facts, except where one is primarily concerned with a particular technical conception of the function of flowers, to call the whole daisy one flower than a group of ray and disk flowers.

Directions: For each of the numbered statements below, on your answer sheet *blacken* space.

A—if the statement is a *true* statement, *independent* of the *organization* and *viewpoint* of biological sciences for its validity, and not a *definition;*

B—if the statement is a *false* statement, objectively untrue despite possible alterations in the *viewpoint* or *organization* of the biological sciences;

C—if the statement might become *untrue* or *meaningless* if the viewpoint or organization of the biological sciences were changed;

D—if the statement is already *meaningless;*

E—if the statement is *true* by *definition,* and hence is independent of other aspects of the *viewpoint* and *organization* of biological science.

7. The petals of flowers are modified leaves.
8. The chromosome number of the cells of the gametophyte generation of a fern is half that of the cells of the sporophyte generation.
9. Photosynthesis enables green plants to convert energy into matter.
10. Blue-green algae are the most primitive of plants.
11. The resemblance of a club-moss to a true moss is superficial; the resemblance of a club-moss to a fern is fundamental.
12. Blue-green algae are too primitive to adapt to the demands of modern biological conditions.
13. Club-mosses are more closely related to ferns than to true mosses.
14. Seeds are living organisms.
15. Members of the highest phylum of plants usually produce seeds.
16. There are four phyla of plants.
17. The flagellate, Euglena, which contains chloroplasts, is an animal.
18. It is not certain whether the moss to which the name *Polytrichum* has been assigned is actually *Polytrichum,* or some other moss which has been improperly identified.
19. Rhizomes are underground stems.
20. Mosses do not have roots.
21. Many kinds of mold are distributed by spores.
22. Corn plants grown from seed in a dark cellar may reach maturity if properly fertilized, but will be lacking in chlorophyll.
23. The development by certain plants of structures of adaptive value to them has increased the proportion of each new generation which survives to reproductive age.
24. The living, protoplasm-filled tubelike tissues of higher plants constitute the *phloem.*
25. Most plants cannot be successfully grown in soils containing no nitrogen.

Since the placement test in which this battery was included was administered before the comprehensive which also contained it, it was theoretically possible to analyze the effect of the course on the same individuals, rather than relying on sampling as was done in analyzing the results on the five items previously discussed. Students entering the College, however, do not usually take Biological Sciences during their first year of residence, unless excused from an unusually large number of courses on placement tests, and it seemed likely that those who did so would not be representative of the total group for that reason. It was decided therefore to analyze samples collected in the following manner:

A random sample of 150 papers was taken from the total group taking the placement test, and a similar sample from the total group taking the comprehensive. The top fifty papers and the bottom fifty papers, on the basis of total score, were then inspected, and the total number of students in each group of fifty who selected *each* possible response to the question noted. *The middle fifty cases were excluded from the study.* It should be pointed out that this battery of items was *not* scored for placement purposes, and therefore did not contribute to the *total* score, on the basis of which the placement papers were divided into high and low groups. It *was* scored for comprehensive purposes, and *did* contribute to the total score upon which the division of these papers was based. Results of the analysis are presented in Table II:

TABLE II

NUMBER OF STUDENTS CHOOSING EACH RESPONSE TO ITEMS 7–25 ABOVE

Placement test students listed in top line of each datum; comprehensive students in bottom line. Answers keyed as correct at University of Chicago are marked by asterisk.

		High 50					Low 50				
Item		A	B	C	D	E	A	B	C	D	E
7	Pl	9	8	14*	2	12	10	8	9*	2	11
	Comp	3	6	32	1	8	5	9	28	2	6
8	Pl	24*	9	1	0	2	12*	6	4	2	5
	Comp	21	25	1	2	0	15	16	6	5	6
9	Pl	20	7*	4	2	13	9	8*	6	2	12
	Comp	22	7	3	1	15	25	7	4	4	10
10	Pl	9	7	20*	1	4	5	7	12*	3	4
	Comp	2	0	47	0	1	10	2	33	1	4
11	Pl	7	2	18	5*	3	9	4	5	6*	4
	Comp	10	0	33	4	2	17	3	19	8	2
12	Pl	3	19*	8	10	1	6	6*	7	7	0
	Comp	0	32	1	17	0	3	29	4	13	1
13	Pl	16	4	15*	2	2	8	5	10*	1	3
	Comp	4	2	43	0	1	11	5	27	2	5
14	Pl	11*	6	7	0	21	10*	4	7	0	15
	Comp	24	0	8	1	17	18	2	5	2	23
15	Pl	17	1	20	2	2*	13	2	5	4	5*
	Comp	6	1	38	0	5	18	0	29	0	3
16	Pl	4	4	29*	2	2	7	7	10*	1	1
	Comp	0	0	49	0	1	1	1	42	0	6
17	Pl	4	6	17*	5	9	4	12	5*	2	5
	Comp	1	4	35	7	3	1	11	31	5	2
18	Pl	1	5	14	15*	1	3	4	10	8*	1
	Comp	5	1	11	32	1	1	0	13	35	1
19	Pl	5	8	2	2	23*	5	3	2	1	17*
	Comp	0	4	9	3	33	4	9	6	2	29
20	Pl	13	13	8*	2	7	10	13	2*	3	4
	Comp	12	1	29	0	8	18	12	12	0	8
21	Pl	39*	0	3	1	2	24*	0	2	1	4
	Comp	46	0	0	0	4	39	2	2	1	5
22	Pl	26	13*	2	1	2	16	8*	3	1	0
	Comp	15	33	0	1	1	17	31	0	0	2
23	Pl	30	2	5	2	2*	12	2	7	2	2*
	Comp	26	4	14	5	1	30	1	14	3	2
24	Pl	4	7	1	5	22*	5	7	2	1	7*
	Comp	1	4	2	3	39	4	7	5	4	30
25	Pl	34*	5	1	1	2	24*	0	5	1	5
	Comp	47	2	0	0	1	43	1	1	0	5

While space does not permit a complete analysis of the date of Table II, there are a number of considerations which stand out rather sharply. The first of these is that, unlike the multiple-choice items cited above, these items were left unanswered by a large number of students taking the placement test, although the students taking the comprehensive—even the lower group—virtually all attempted to answer them. This seems to indicate that the conception dealt with was so unfamiliar to many students taking the test, at least as presented in this battery, that they hesitated to commit themselves at all. It is true, of course, that student motivation is also lower on placement tests than on comprehensives, and one cannot distin-

guish wholly between the effects of these factors. Nevertheless, the conclusion that this kind of thinking became familiar to large numbers of students only through the experience of the course seems warranted.

On each of the individual items themselves, if the course was effective in developing insight into the structure underlying the organization and viewpoint of the biological sciences and the battery effective in measuring such insight, one would expect that the answers keyed as correct would be chosen more frequently than other responses, and that the correct answers would be chosen more frequently by students taking the comprehensive examination than by those taking the placement test. Examination of those instances where either or both expectations have gone unfulfilled should therefore be revealing. Actually, incorrect responses were often more popular than correct ones, and only the more striking cases can be discussed. Where such reversals occurred, as they commonly did, among the "low-placement group" it is doubtful if much significance can be attached to them. Only five cases of placement-group superiority or equality are found, and each of these is also a case in which responses other than that keyed as correct were most popular among all groups, except for one case in which this was true only for the comprehensive groups.

The five items in which the placement test performance was superior to the comprehensive performance for one or both groups are 8, 9, 11, 13, and 23. In all but item 8, all four groups—high, low, placement and comprehensive—chose unkeyed answers more frequently than keyed ones, while on 8, both comprehensive groups did so. In order to form a hypothesis to account for these anomalies, the items themselves should be examined.

Item 8 does not appear to give a true instance of failure to reach the "Area D" objective. What seems to be the case is that students who had not had training in the biological sciences had too little knowledge to have any reason to regard the item as false, whereas those who had actually taken the course had some basis for confusion. Since, so far as the "Area D" objective is concerned, responses A and B pertain to the same category—independent factual statements—this does not seem to be relevant to success in achieving objectives in Area D.

Performance on item 9, too, seems to be due to astonishing misinformation purely. These students simply believe that photosynthesis is a means of converting energy into matter. They believe it when they come, and they believe it even more strongly when they leave, especially the poorer ones.

The evidence derived from item 11 is far less easily interpreted; the results here seem to stem partly from a real failure to achieve the objective measured, and partly from ambiguity in the item. Those students who keyed the item as C evidently felt that, if the framework of biology is accepted, the resemblance between related species is "fundamental"; to the degree that they recognized that the acceptance of the framework is what makes it so, they have progressed toward the objective. The statement as it stands, though, is nearly a perfect semantic example of a meaningless statement, and should have been keyed so. Those students who keyed the item as A, thus placing the "fundamentalness" of the resemblance between related species beyond definition clearly have not thereby given evidence of progress. Yet A-responses apparently increased as a result of having had the course, especially among the poorer students.

Results on Item 15 are easily explained; item 15 is a bad item. It is very ambiguous and, in retrospect, the author, who set up the key, is almost inclined to agree with the students who keyed it C. What was intended was the inference that, since seed-production characterizes spermatophytes,

and since these are regarded as the highest phylum, the statement is true by definition. The students, by no means improperly, fell on the question of what made spermatophytes the highest phylum in the first place, and chose response C. Those who chose A were, as with item 11, far afield.

Item 23 was apparently mistaken by many students for a factual statement about adaptive value rather than, as the author believes it to be, a definition of it. There is perhaps room for argument here, but in general, this seems to be authentic evidence of failure of students to recognize a definition when not placed in the classical form: "Adaptive value is. . . ."

It seems quite clear, from the evidence of this battery, that the skill here measured in which students grew most was that of distinguishing those statements which depend for their meaning on the mode of organization of the biological science field. This is the key behavior of "Area D", and it is therefore gratifying that all 6 items keyed as C functioned splendidly. The poorest item, 15, would not have done badly as a C-item, and might well have been so keyed. Difficulties with items keyed A and B occurred chiefly when students, through ignorance of the facts, confused the true with the false; the skill in distinguishing factual from definitive, meaningless, or organizationally-derived statements seems to have developed adequately. However, two of the four statements classified by the author as definitions misfired, partially through ambiguity, and partially through a real failure of students to identify a definition when not presented in classic form. Of student response to the meaningless statements, there being only two, it is difficult to make a statement which would not itself be meaningless.

The chief conclusions, then, which may be drawn on the basis of these data are quite general. It seems safe to state that student insight into the organization and viewpoint of Biological Sciences has been increased, and the increase successfully measured. It seems safe further to conclude that no comparable success has been demonstrated in developing or measuring the subsidiary fine skills, of which the detection of the meaningless, and the recognition of definitions, are examples; whether this is due to deficiency in student achievement or in measurement is not certain. Nevertheless, the results cited in Tables I and II do show considerable student growth on many of the items measuring in Area D. It is hoped that the material presented will provide a useful point of departure to others interested in further development of student capacity to distinguish between the content and structure of their particular discipline.

THE WORKBOOK IN SCIENCE IN CONNECTION WITH THE COURSE-OF-STUDY

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I. INTRODUCTION

IN this article workbooks are considered as a legitimate outgrowth of the course-of-study.

E. P. Andreen[1] defines the types as: general—for any text, and specific—for a specific text. The former has its greatest use in directing expressional activities from a great variety of sources. The specific type is especially adaptable to an intensive reading program of a specific text. In the hands of an inspired teacher, well-trained in teaching reading and study habits, such a workbook might serve to lessen the burden of lesson planning on the part of the teacher and serve as a guide to students in study hall, library or at home as well as in class. Several companies are

printing combinations of texts and workbooks. In the hands of the poorly trained teacher, a well-developed workbook may often mean the difference between fair success and absolute failure.

The general type workbook seems to be more applicable to "good readers" who are interested in a varied diet and wish to use their own discriminations in the selection of reference materials. These people are the ones who use the library most successfully and are most able in integrating what they learn from reading, experiments or demonstrations, lectures, projects, films and other visual aids, museum displays, artistic attempts, field trips, and from asking questions. The workbook, in this case, serves as a guide to the boundless energies of ambitious students. The danger here is to the poor reader and especially to those poor in initiative and who are not well-trained in all methods of study used by workbook and teacher.

The word "workbook" is really applied to materials not provided in conventional textbooks and which are organized primarily to enable the pupil to learn all the basic techniques or abilities required for the mastery of the subject. Usually workbooks present materials in a definite sequence and are more systematically and painstakingly organized than the day-to-day teacher-made materials often seen in poorly-mimeographed form. (Such exercise sheets and tests should be typed by expert clerical help if done at all.)

A great amount of adverse criticism to workbooks has developed because of the large number which contain pages of blank spaces to fill. Other criticisms are made as follows: that they tend to stress memorizations of facts rather than elaboration of principles; minimize individual differences; are followed too slavishly; include busy work; emphasize speed to the neglect of accuracy. Needless to say, those who have the better workbooks in mind often cite examples where opposite conditions prevail.

Since 1930, the production of workbooks and their use in classrooms has definitely been on the increase. In line with the production of better textbooks, workbooks are improving as writers secure greater experience in the success or search in educational procedures. Almost all texts printed recently have an accompanying workbook. Only a small number of such workbooks cite references to textbooks of competing publishers; thus providing a real reason for school boards to authorize publication of local, teacher-written "guides" to the student.

A number of articles have appeared in magazines, which upon first glance seemed definitely against the trend toward workbooks, but surprisingly, support the type of workbook which meets local needs and which give due consideration to children's interests.

Large and unwieldly classes have undoubtedly increased the demand on the part of teachers for such aids to teaching as workbooks. On the whole, the success or failure of workbooks will depend upon how the individual teacher directs their uses. Mistakes are made in directing their use, but possibly not so many as would be made without them.

II. SUPERVISION THROUGH COURSE-OF-STUDY AND WORKBOOK CONSTRUCTION

The statement has frequently been made in educational writings that curriculum construction and courses-of-study development are very good methods of improving instruction. Teachers learn by doing; learning what not to do, as well as, what to do. More than one supervisor has remarked to the writer that course-of-study revision (including cooperative development of teaching units) was an excellent method of supervision.

A cooperative course-of-study development in General Science was begun years ago by teachers and supervisors in the Cleveland Heights Junior High Schools. The course-of-study was developed rather independently of existing texts with the idea that science should, as far as possible,

be of an experimental and observational nature; more biological units were to be incorporated than were contained in texts of that time; and the spiral development of subject matter was not to be used insofar as to teach units piece-meal, i.e., begin a unit in one grade, continue it in the next, and complete it in the ninth. (The latter was a trend in some series of texts at that time. That trend caused difficulties where the school population was not static and particularly so if the material of all units was of a developmental or spiral type.)

Teachers individually began writing and mimeographing work sheets. About 1931 "Guide Books" were printed. These workbooks were of topical form. In 1934 these related subject matter; biological units, where field trips and collecting were desirable, were placed in the early fall and late spring months of grades seven and eight; and units were further arranged so that pupils of any one grade studied units according to seasons or periods of the year, i.e., both "A" and "B" sections study the same units concurrently. The latter plan saved teacher time by eliminating almost half the number of demonstration set-ups, i.e., an 8B would see the same demonstrations, experiments, films, etc., as an 8A. The teacher thus had more time to provide better and more frequent demonstration.

The writer gained considerable experience in helping to write, and in editing, the course-of-study and "Science Guide" revision of 1938. In preparation, the literature of science writers and that of educators was consulted. Outlines of content pertinent to the modern course-of-study were made and discussed in committee. Films and other visual aids, demonstration or experimental equipment, and new library references, were investigated with the idea of integrating those suitable to the various grades into the units as developed.

Units previously used were re-arranged on the basis of experience in teaching, and modified according to the aims and objectives selected for each. In general, *Standards for the Reorganization of Secondary School Curricula by a Committee of the North Central Association of Colleges and Secondary Schools were followed.* The student activities developed were to be guided by one or more of the "Seven Cardinal Principles for Education" with emphasis upon Social, Health, Leisure, and Vocational functioning.

III. CRITERIA USED IN DEVELOPING A WORKBOOK AND ITS COURSE-OF-STUDY

A list of criteria and definitions followed in constructing the general science course-of-study and its related set of student "Guides" or workbooks were as follows:

1. The Science Guide, for Junior High School use by students, was to be an exercise book; accent to be on inductive material and on activities, mental and physical. It was to furnish exploration and applications in science as part of the educative process for proper citizenship and for daily life.
2. The material was largely to apply to pupils, but suggestions of possible visual materials and other pertinent references or demonstration suggestions were in some instances incorporated. Grade and teacher experience in the various grades of the Cleveland Heights Junior High Schools was utilized. (McGuffy is said to have re-arranged his reading series on this basis.)
3. Unit concepts were to be selected on the basis of major concepts in science and stated major concepts to be taught in the three year sequence were to be kept in mind while planning details of each unit. An example of one such concept used was: "Energy is the basis of all motion and of all life. It is readily transformed from one kind to another for man's use, if we know the secrets of science and have the proper tools to use. Man often uses his knowledge to disturb the balance of nature" [4, pp. 39–48]. Martin [2] and Olds [3] have selected similar lists of principles such as are suitable for general courses in biology.
4. Under each problem were listed necessary topics for answering the problem questions. These were usually in the form of directions—activities stated in imperative sentences. The necessary chapter references to supplementary texts were attached to each problem.
5. Each topic under a problem contained one or more of the following:

a. A thing which the pupil was to do.
b. A problem played with, and worked with too.
c. A basis for inductive teaching.

6. Additional units or additional applications were supplied for those who mastered the required ideas.
7. The number of exercises for each unit were not to exceed an average of fifty, plus twenty optional exercises for a four-weeks' unit. Sub-exercises were not to be used. The hardest job was—what to leave out. No exercise was to be used which did not directly help to answer the problem question. Optional exercises were to follow the regular exercises of each problem and were to be designated by letters a, b, c, etc. From three to eight optional exercises were expected to be sufficient for each problem.
8. Each exercise used was to be evaluated as to whether it contributed to the health, social, leisure, or vocational needs of the student.
9. An exercise (Topic) was to be an assignment for pupil's use. As such, it was to fulfill the following conditions:
   a. It should contribute to the *understanding* that is involved in the problem under which it is listed.
   b. It should constitute something for a pupil to attempt—a conclusion to be reached, a principle to be understood. Class discussion should precede or follow the topic.
   c. Subject to the teacher's preview or development, it should include all necessary directions for the pupil.
   d. Its execution should depend only upon materials that are known or assumed to be available, whether books or materials. Only *extra* or *optional* exercises should require independent search for authorities, collection of materials not available to all, etc.
   e. The terms used in the statement of the exercise should recognize these principles. Imperatives given below indicate what is meant:

Suitable

Name orally .....
Learn this list .....
Consult the dictionary.....for.....
Observe (the result of an experiment described) .....
Make a poster showing.....
List .....
Give examples .....
Plan for visits.....by (detailed description)
Secure pictures .....
Write.....conclusions for your study of .....
Demonstrate .....
Collect materials .....
Examine.....and describe.....
Read.....and explain.....
Find out.....(certain information)
Tell what you can.....
Draw .....
Review .....
From your readings, classify.....
Sketch .....
State .....
Explain .....

Doubtful (better used for response after topics have been discussed, as in tests or for optional use)

Discuss .....
Investigate .....
Think of .....
Compare .....
Show how .....
Determine .....
Imagine .....
Report upon .....
Classify .....
Do research .....

10. The word "observe" is applicable as a preface to directions for teacher demonstrations and experiments, however, some further direction for the active participation of the student was to be included in the exercise. The word "write" was to be sparingly used as the majority of teachers preferred more oral participation. [It is easy to require writing as a matter of instructing a class which needs to write. Otherwise voluminous notebooks (sometimes copied from others or from texts) becomes the rule.]
11. Numbering of topics was to be upon the unit basis rather than repeating numbers for each problem. Omnibus exercises were to be divided into reasonable, definite exercises of practical worth, in such a manner as to be usable as written work, oral report, or as a guide to study. (There should never be a question in the student's mind as to what is required of him.)
12. Demonstrations to perform were to be definite as to procedure, and selected with the idea of class rather than individual demonstration.
13. The vocabulary list at the beginning of each unit was to be limited to about thirty words selected from the reading content of the basic text and of the references selected for the grade in question. Word relationship rather than alphabetical listing was adopted.
14. Names of the basic texts were to be listed in the Guide. Other books of a more general nature such as Conn: *Bacteria, Yeasts and Molds,* the *Boy Scout Merit Series,* or Reed: *The Stars for Sam,* were to be listed at the beginning of the unit as Library BOOKS FOR INTERESTING READING. Good pamphlets were to be listed where procurable in numbers and not likely to go out of print soon. Attention to proper reading-level references was to be of prime consideration.
15. The use of new visual materials were to be considered in selecting subject matter.

(Note: Eighteen Erpi sound films and twelve Eastman films were finally selected as most useful and a picture from each was inserted in appropriate "Guides.")

16. Subject matter selection for the greatest pupil interest at the given psychological grade-level was to be kept in mind. (An organized sequence of facts of physics or of botany are of little use in a general science course if they are so advanced in character that the average junior high school pupil is discouraged by their very magnitude. Conversely, units which are too simple bore even the average pupil. "Talking down" to children annoys them. Problems should seek to "catch" interest.

17. Emphasis was to be placed upon problem learning or understanding on the theory that an exercise or experiment by itself means little unless related to other exercises and unified into broad concepts represented by the problems and the unit question.

18. It was the stated purpose of the *Guide* and of the teacher to make the learning conditions as nearly like the conditions in real laboratories and life situations as possible. Together they were to confront the student with interesting problems, surround him with books full of facts to look up the needed information; and in general, act as stimulating and motivating influences to scientific thinking.

19. Although information, units and topics, presented in textbooks are similar, it was noticed in actual use of various texts that variations in the emphasis, organization, and methods in presenting such information created greater interest for students allowed a choice of several texts beyond that of students restricted to the single style of one textbook. For this reason several reference texts and other incidental or specific sources of information were selected for each grade level in addition to the basic text adopted.

20. It was noted that if problems and exercises were to be realistic to the student they must be pertinent and necessary to the understanding of the unit; they must be difficult enough so that he will not guess the result. If they were to be interesting, they must be within his own experiences. If they were to be challenging, they must present an obvious need for solution. The problems were to consist of experimental work, careful observation, checking of data, as well as confirmation of results by the use of textbooks and other sources of authority.

21. In summary, the organization of the workbook unit was to be as follows:
    - Title of the Unit—(I to VIII for each grade).
    - Special classroom references used in the unit.
    - Library readings of particular value (to the pupil).
    - Vocabulary (spelling and definition of new words).
    - Problems (usually no more than six or seven problems in all).
    - References (for each problem, with page numbers).
    - Exercises (number as needed to develop the problem), later labeled topics.
    - Optional projects and investigation marked a, b, c, etc., for each problem.
    - Self-testing exercises (finally omitted in favor of learning-type tests).

22. Organization for the Course of Study to precede the workbook or "Guide" was to be according to the following outline:

Grade	Unit	Approximate Teaching Time

A. *Objectives* (The following types reported in SCIENCE EDUCATION and sponsored by Beauchamp, W., should aid in your decisions):
   1. Health (the first cardinal principle).
   2. General utility (to pupils, and about the home).
   3. Interpretive value (of natural phenomena).
   4. Scientific attitude (desire to investigate and weigh evidence before arriving at any conclusion).
   5. Aesthetic value (appreciation of beauty in and wonder of nature and natural phenomena).
   6. A vocational value ("hobby" science).
   7. Ethical value (bearing upon social and moral problems).
   8. Inculcation of habits (neatness, accuracy, discrimination between truth and falsity).
   9. Emotional standards (to prevent sudden unfounded emotions).
   10. Vocational value (exploration of vocations).
   11. Others.

B. *Fundamental Concepts of the Unit* (problems)
   1.
   2.
   3.
   4.
   5. etc.

C. *Suggested Children's Activities:* (collections, art posters, projects, visits, home experiments, essays, model making, visual aids, reading, constructions, field trips, etc.)

D. *Desirable Outcomes:* (health, leisure, social, vocational to be emphasized)
   1. Acquiring fruitful knowledge (examples).
   2. Developing interests, ideals, attitudes, appreciations (examples).
   3. Developing techniques in memory, imagination, judgment, reasoning (examples).

4. Acquiring right habits of conduct and useful skills (examples).

E. *Outstanding References:*
1. Teacher references. (Books for background enrichment).
2. Pupil references. (A variety of grade-level publications).

F. *Suggested Materials:*
1. Equipment.
2. Supplies.
3. Visual Aids.
   a. Sound and silent films.
   b. Filmslides and micro-slides.
   c. Models, charts, maps, collections.

IV. SUPERVISION OF THE USE OF WORKBOOKS

Supervision does not end with the development of the workbook. Its successful use depends upon the teacher. Any workbook can be used successfully only when all integrated factors of teaching appeal to the psychological and physical well-being of pupils. Workbooks or any single method of teaching can become boresome and no one method or technique must be leaned upon too heavily. No teaching can be automatic. It is the job of the supervisor to see that the best methods and procedures are in constant use.

Edgar Dale [5] stated a concept of teaching, similar to that which the Science Committee has attempted, as follows: "If there is one thing that has been discovered in research in the field of learning, it is that there are very great individual differences in the way that students learn. Some learn best by listening, by asking questions, by talking with others about the problem. Some take readily to books and have great skill in getting information and understanding from the printed page. Some find understanding through the laboratory and manipulative activity. Some learn by getting ideas visualized, charted, graphed, pictorialized. There is no royal, no single road to learning.

If these statements are accepted as true or even as partially true, it would seem to argue for much greater flexibility in the learning materials used in our classrooms. We would avoid any strait-jacket of methods, whether it be recitation, laboratory, lecture, or whatnot."

Some of the difficulties of both experienced and beginning teachers are as follows:

a. Failure to understand the intellectual limitations of students. (They all like to do a certain amount of creative and reference work, but each student has his own limitations. Junior high school work is not college work; however it is also not elementary.)
b. Failure to comprehend the limitations of study time. (The requirement that a student should write the answer to all topics or any except those especially selected and assigned by the teacher, is frequently too great a requirement.)
c. Use of single methods of teaching, ignoring the value of the many visual aids, experimental devices, special reports, projects, etc.
d. Assignment of new words for complete learning before presenting the need for the words as they are encountered in the unit. (Vocabulary lists are placed at the beginning of each unit for convenience. Some Latin and biology texts use this procedure. The writer has found that a student is helped if he uses some time at the beginning of a unit to discuss the words as to pronunciation, meaning and relationship to the unit. After the unit has progressed, so that most of the words have been encountered in the unit, a spelling lesson is given. Almost all students then spell the words correctly. Meanings of words are further discussed as they enter into each problem assigned.)
e. Holding all children to specific achievement without recourse to the normal curve in grading. (Constant demand for impossible achievements on the part of a pupil can, and probably often does, cause mental deterioration. Where classes are too large for much individual attention, the writer favors homogeneous grouping of slow students so that assignments for a class can more nearly be made to conform to the ability of the individual student. In the case of the lowest group, provision has been made so that certain topics, and in some cases problems, need not be taught.)

New textbooks and workbooks are now on the market, which are greatly improved over older editions. Constant improvements are being made. The old type of workbook with blank pages predominating is on the way out. Textbooks and workbooks which give consideration to grade-level reading problems and appropriate pupil experiences are on the way in.[6, 7] Provisions must be made for supplies of reference materials required by both retarded and accelerated readers.

Less notebook work of the old type is the order of the day. Perhaps more essays in answer to problems, in general, and more construction of posters and projects to illustrate visually the ideas of topics of recitation will substitute for the old order. More films or filmslides, museum study, better library and reading instruction, and better demonstrations or pupil experiments will provide more interest in secondary school studies.

W. G. Brink,[8] gives an excellent summary of activities involved in the study of science and the analysis of such activities. His conclusions indicate that the trend of teaching is towards "directing expressional activities" in true-to-life situations. The portion of a course-of-study cited in this book as typical of this trend seems quite similar to the one described in this paper.

V. CONCLUSIONS

A most vexing problem to school authorities is that of determining whether to adopt a ready-made course-of-study and its accompanying textbook, workbook, and testing program, or to develop such a course within the system.

The final decision might properly be determined by the following local factors:

1. Needs of the pupils now and as future participants in our democracy.
2. Philosophy of the administrative and teaching personnel.
3. The adequacy by which existing courses-of-study meet the needs of the pupils to be taught.
4. Ability and special training of the teaching corps.
5. Available school time which may be allotted for such work. The course-of-study must be completely planned and completed in all respects if it is to be locally constructed, or thoroughly weighed in all respects, if adopted from elsewhere. Too many administrators are content with the mere selection of a text or workbook, often with no true evaluation of content or applicability to student needs.

Happily, complete courses quite acceptable to most, if not all, school systems have recently been published for most of the sciences. It is probably advisable that nearly all school systems adopt such prepared courses whenever such courses are found to meet local needs. Exceptions should be in those schools where conditions are such as to indicate that a locally prepared course could furnish a special contribution to the education of students. Teachers who, through necessity, have to work at additional jobs in order to make a living cannot be expected to do much curriculum work.

New inventions are rarely the result of the activities of a single person or group, but the outgrowth of the thinking of many persons over a period of years. Likewise curriculum improvement of any great magnitude results from the thinking and actions of philosophers, curriculum authorities, research workers, subject-matter specialists, writers, supervisors, and classroom teachers.

Good curriculum work is arduous and demands much investigation and other time-consuming activities. Lasting worth could result only from the work of a group specialized and trained in all phases of the work, and who were experienced in teaching the subject to students for whom the course is intended.

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ABSTRACTS

EMERSON, HAVEN. "What We Have Learned About Alcohol." *The Phi Delta Kappan* 30:89–90. November, 1948.

Doctor Emerson, Professor of Public Health Administration at Columbia University, says:

"We have learned that misinformation developed by advertising, and ignorance resulting from ill-balanced common school education, are largely responsible for the social habits of many who become drinkers of alcohol. I count that nation derelict in its duty in education if it teaches a child about milk and fails to teach him about alcohol. . . . We have learned that the taste for alcohol is not a hereditarily or genetically acquired condition. . . . We have learned that alcohol, as commonly used today, causes more disease disability and death than any other cause of ill health which is wholly in the power of the individual to prevent and avoid.

Since the end of the war in Europe there have been more deaths among American troops from alcohol than from all communicable diseases combined. Alcohol is not a food or a stimulant, but a depressant, narcotic drug. Alcohol is far more damaging to the brain and spinal cord than to the liver, stomach, and heart. Life-saving reflexes of the body are slowed 5–10 per cent by amount of alcohol too small to be socially appreciable.

There is no form of human activity so far tested which does not show inferiority of performance as the invariable sequence of the absorption of alcohol.

HARTFORD, ELLIS FORD. "Why Two Hundred Chose Teaching." *The Phi Delta Kappan* 30:126–127. December, 1948.

The following reasons were given in order by 200 University of Kentucky education students for selecting teaching as a profession: 1. Teaching is important work; 2. Interest in and liking for children; 3. Teaching is interesting work; 4. Teaching offers great personal satisfaction; 5. Teaching offers opportunities for advancement now; 6. Teaching keeps you learning and growing; 7. Teaching is opportunity to help others.

WILLIS, H. L. "Some Further Facts Suggesting that Our Sun is a Variable Star." *Popular Astronomy* 56:370–378. August, 1948.

Mount Rainier in Western Washington is shrouded in perpetual snow with a magnificent array of glaciers—seventeen in all and four to six miles long. During the past hundred years the glaciers have been retreating. The answer seems to be the climate must be getting warmer. A study of weather bureau records confirms this. This is true not only for western Washington but for the whole United States—in fact the whole world. Winters are not as cold as they used to be! Increases in average annual mean temperatures varies from one to three degrees. This increase in warmth seemingly has been going on since about 1870. Previously there had been a period of decreasing temperature beginning about 1817 or earlier. Undoubtedly the sun is radiating more heat now. The conclusion seems irresistible that our sun is a variable star—a very long-period variable with very small range.

BARTLETT, JR., JAMES C. "Solar Bookkeeping." *Popular Astronomy* 56:470–477. November, 1948.

Constant and careful study of sun spots show that contrary to popular opinion, sun spots are very short-lived—averaging from two to three days. Goups do persist for a much longer time—even months.

GRANT, CHAPMAN. "Meteoritic Origin of the 'Carolina Bays' Questioned." *Popular Astronomy* 56:511–527. December, 1948.

The author presents a detailed study and much evidence that the "Carolina Bays" could not have been formed by meteorites. In the aggregate, the Bays are elliptical which is at variance with all lunar and earthly meteoritic craters. The form of the area is not consonant with any "swarm" of meteorites or comets head.

The Bays were formed by either: 1. Bombardment from space; 2. Geophysical forces; 3. Biological agencies. The author believes the first two can be disproved. Briefly, his theory is that they were formed by schools of a now extinct specie of fish spawning in a sheet of water flowing northeasterly with a wind blowing over the area from the northwest.

FARNSWORTH, DEAN AND BERNES, CONRAD. "Color Blindness." *Hygeia* 26:619, 666. September, 1948.

Seventy-five years of attempts to "cure" color-blindness reached their climax during the recent war. Six authoritative organizations give conclusive testimony that no method has been found for the correction of color-blindness, whether called "color weakness," "color confusion," or "color defectiveness." Men can be coached to pass tests, but their physiologic deficiency cannot be repaired. Any claims to the contrary, any "treatment" which convinces operators they can see colors they could not see before will decrease safety in transportation, decrease security in national defense, and decrease efficiency in industry.

MALLORY, VIRGIL S. "Meaning in the Junior High School." *The Mathematics Teacher* 41:251–259. October, 1948.

The article develops the following theses: 1. In order for mathematics to be useful to the child, it must have meaning; 2. Drill or practice in processes in mathematics is necessary in every grade from the first through college mathematics; 3. Meaning and understanding must be defined in terms of child's actual reactions, not in terms of what the reaction should be; 4. Every

teacher of arithmetic should know well how arithmetic is taught in the lower grades; 5. At all stages in the teaching of arithmetic the development must begin with the concrete then go to the abstract and finally be applied in the concrete situations of real life; 6. Understanding is hindered by the use of words or devices that conceal mathematical meaning; 7. A critical survey of materials of instruction in grades 7 and 8 should be made to be sure that all have social meaning for the child; 8. The mathematical concepts developed must correspond to the pupil's maturation; 9. We cannot allow our program to entirely ignore the brighter student.

McCUE, J. J. G. "Ancient Science in the Modern Curriculum." *American Journal of Physics* 16:404–408. October, 1948.

The nature and history of scientific activity should be a part of all science courses, including physics. The early Greeks made many significant contributions to science. Too often our impression of Greek science is based on the works of Plato and Aristotle, whose chief interests and skills lay in other fields of learning than physical science. The works of the best Greek scientists were at variance with the religious views of Christians, Jews, and Moslems on whom we were dependent for the transmission of Greek learning. Thales, Pythagoras, Anaximander, Anatagoras Aristarchus, and Eratosthenes made real contributions to science.

Aristotle understood the function of research and contributed enormously to biology by careful investigation. But in his contributions to Physics for which he is best known, he contributed heavily to the Greeks' reputation as poor scientists. Aristotle made two major mistakes: he attempted a synthesis explaining all dynamical phenomena in terms of first causes and he underestimated the importance of quantitative observation.

COOPER, C. E. "Some Principles of Geography." *The Journal of Geography* 47:234–239. September, 1948.

Too many teachers of geography place too much emphasis upon facts. In fact, that is the sole stress. The author does not underestimate the importance of facts, but insists they should be taught in connection with principles of geography.

Several principles of geography (stated in declarative sentences) are listed. These relate to: location, areas, form, land forms, water bodies, weather and climate, soils, minerals, plants, animals, and man.

HART, J. F. "A New Map of Tung Production in Southeastern United States." *The Journal of Geography* 47:311–313. November, 1948.

Tung oil, which is used as a drying agent in paints and varnishes, or as a waterproofing agent, was not produced in significant amounts in the United States until World War II. About sixty-four per cent of the tung nuts of the United States are produced around Bogulasa, Louisiana. Limiting factors: a well-defined three month dormant season, freezing temperature soon after tree drops its fruit, forty inches of annual precipitation, slightly acid soil, and adequate air and soil drainage.

BOOK REVIEWS

DEWHURST, J. FREDERICK AND ASSOCIATES. *America's Needs and Resources.* New York: The Twentieth Century Fund, 1947. 812 p. $5.00.

America's Needs and Resources is the most comprehensive study the Fund has ever undertaken. It presents a careful estimate of America's human and industrial capacity and resources balanced against the probable needs and demands for 1950 and 1960.

It is truly a fact-book of the American economic system. This survey covers records of production, consumption, and economic change in the United States within recent decades, and in many instances it goes as far back into our economic history as reliable records exist. It ranges over broad-gauged basic data on population growth, national income, trends in employment, working hours, output per man-hour, and similar subjects. It gets down into detailed analyses such as indexes of crop yields per acre, consumption expenditures for single items, such as for shoes, in each year, 1909 through 1942.

Major parts of the study are: 1. Basic trends; 2. Consumer requirements; 3. Capital requirements; 4. Government costs and foreign transactions; 5. Resources and capacities; and 6. Summary.

All Americans including science teachers should be vitally interested in each phase of the report. Specific interest of science teachers should focus on the part dealing with natural, agricultural, and industrial resources.

HIGHLIGHTS OF THE FINDINGS

America is fully equipped to outdo even her wartime production record in the decade 1950 to 1960, according to the Twentieth Century Fund's comprehensive survey of *America's Needs and Resources,* which indicates that if we can continue our past rate of growth through the next decade we can provide our people with still more goods and services than at the wartime peak, with less hours of work.

The survey measures past accomplishments and estimates future output and needs in virtually every part of our entire economic system. Dr. J. Frederic Dewhurst, Economist of the Fund, directed a staff of twenty experts in a three-

year study and did the principal part of writing and editing the final report.

Some outstanding findings and conclusions of *America's Needs and Resources* may be summarized:

1. America's sensational achievements of the past are measured by figures which show that the net output of our economy was 27 times larger in 1944 than in 1850, turned out by a labor force only 8½ times greater and working only 47 hours a week instead of 70. Our total national income (or net output of all goods and services) produced in 1944 was $161 billion as against $6 billion for 1850 in terms of 1944 prices.
2. This enormous increase in output raised the income of the American people—averaging men, women and children—from around $270 per person in 1850 to about $1,170 in 1944.
3. Gross national product, or the total of all goods and services produced in this country, can well reach $177 billion in 1950 and $202 billion in 1960, if we operate our economic system at levels as high as we attained during the last half of the 1920's. The 1960 figure is higher than our wartime peak output of $200 billion in 1944, and indicates that we are easily capable of a national output in 1960 that is nearly three-fifths higher than our last prewar year, 1940; and 88 per cent higher than our "boom" year of 1929. All figures are in terms of 1944 prices.
4. Jobs would show a total of 57 million in 1950 and 60.2 million in 1960. These estimates allow for about three million unemployed in each year and they compare with our total employment of about 47 million in 1940.
5. The average work week probably will go down to 41 hours in 1950 and 38 hours in 1960, as compared with an average work week of 43 hours in 1940 and over 47 hours in 1930.
6. Output per man-hour of work, due largely to the tremendous amounts of machinery and mechanical power with which America backs up its workers, may well increase by 18 per cent or more during the decade of 1950 to 1960. This figure represents the average increase of all the decades between 1850 and 1940. Today, when an American works one hour he produces more than a worker anywhere else on earth or at any other time in history.
7. All these estimates show probable demand and indicate what our future activity may be if based on actual performance in the past. If estimates are based on "needs," figured as how much more output would be needed to supply every living American with minimum standards of health and decency in food, clothing, housing, medical care, education and other goods and services, gross national product would be 13 per cent greater than the 1950 estimates, and 8 per cent greater than the 1960 estimates.
8. Possibilities for more jobs and still higher business prosperity in the decade are indicated by the margin of still-unsatisfied minimum needs, so that if those needs—and those markets—are met, gross national product would go from the estimated $177 billion to $200 billion in 1950 and from $202 to $219 billion in 1960.
9. Far from being "mature" or "dead," the American economic system is a dynamic, growing thing. It holds possibilities for capital expenditures: for starting new businesses, for producing such capital goods as new factories, stores, new school buildings, new hospitals, highways, railroads and transportation systems, etc., etc., probably beyond our capacity, so that a vast area for still greater expansion lies in the future.

Implications of the Survey

Commenting on the significance of this report, Evans Clark, Executive Director of the Twentieth Century Fund, says in his Foreword:

> "Our inventive genius, our organizing ability and our skills have given us here in the United States the greatest productivity and the highest standard of living in the world, enjoyed by the largest proportion of the population—in spite of our strikes, depressions, unemployment and economic wranglings. If we can prevent the universal devastation of atomic warfare, and if we can continue to spread the benefit of a constantly increasing productivity in the United States, we can go on to economic and cultural heights as far—and farther—above those of today as those of 1947 are beyond the imaginings of our great-grandfathers back in 1840. This challenge cuts across the lines that all too often separate us into angry pressure groups. It tends to draw us all together in the one common cause of greater and more continuous production with a more fair and reasonable distribution of the benefits."

What We Did In Wartime

Dr. Dewhurst begins the survey with an analysis of the "miracle of production" that we achieved in wartime. He shows that at the peak of the war effort in 1944, consumers actually received more goods and services—even with half of our total production going to government, largely for war purposes—than in prosperous 1941. Because large classes of goods, such as automobiles and sugar, were scarce or unobtainable, however, many consumer wants were unsatisfied. Gross national product reached nearly $200 billion in 1944.

Far from seeing any "magic" in this tremendous achievement, Dr. Dewhurst soberly points out that "the doubling of our dollar volume of out-

put during the defense and war period can be accounted for almost entirely by higher prices, more workers and longer working hours." He estimates that almost one third of the increase between 1940 and 1944 was due to price rises alone. In addition to absorbing virtualy all our 1940 unemployed, we brought into the labor force about seven million "emergency" workers (housewives, older persons who might normally have retired, etc.), and increased the average work week to nearly 47 hours. Dr. Dewhurst shows that, contrary to widely held impression, our rate of production or output per man-hour, did not increase in wartime. Indeed, he points to "our failure to achieve substantial gains over (or even to maintain) prewar productivity."

Can We Do It In Peacetime?

Since most Americans ordinarily do not wish to work under these forced draft wartime conditions, Dr. Dewhurst estimates 1950's total output of $177 billion in goods and services as approximately 10 per cent less than our wartime peak in 1944. These and most other estimates in the survey are quoted in terms of 1944 prices, which are about 15 per cent lower than present price levels.

Trends in Government Expenditures

According to the Fund report on *America's Needs and Resources,* one item almost certain to increase sharply is money spent through national, state and local governments. "Total expenditures of all United States governments in 1950, according to this survey's estimates, will exceed $45 billion—nearly four times the dollar amount spent in 1929, two and a half times the 1940 total. . . . When comparisons are made in dollars of constant purchasing power the 'real' advance in government costs, though much less striking, is still about twice as large as the rise in gross national product."

"Needs" versus "Demand"

One whole set of estimates in the survey is reached by carrying forward past experience to show what our probable demand for and output of goods and services will be. Another set is based on "need": the output needed if we placed no "ceiling" over the expenditures of those with plenty to spend but did place a "floor" under our economy by producing enough to provide minimum standards of health and decency for every person in the country.

Meeting Our Needs

For example, for the largest consumer need, food, the Twentieth Century Fund survey says: "To provide nutritionally adequate 'moderate cost' meals for those unable to afford them in 1950 would cost about $5.5 billion—or about one fifth more than the estimated $27.2 billion that will probably actually be spent for food and nonalcoholic beverages in that year."

Similar analyses and goals are set up in a wide variety of consumer needs, such as education, clothing, housing, household operation, medical care, and religion and welfare. All go to make up part of the higher figures for gross national product of $200 billion in 1950 and $219 billion in 1960 that would be required to meet the country's minimum "needs."

Increases in Capital Goods

If our country is to supply these needs, the report points out, we must have large increases in our "capital goods"—the plant and facilities that will enable us to turn out the additional goods and services. Higher standards for housing, education and medical care, for example, would mean new houses, schools, hospitals, etc. The report estimates total needs for capital expenditures, both public and private, of $34.5 billion in 1950 and $37.9 billion in 1960.

Agriculture and Natural Resources

Considerations such as these bring the survey to a basic question: Have we enough total resources in America to meet these total needs? In the matter of agricultural products to supply our food, we showed spectacular achievement during the war. "Indeed, the remarkable accomplishments of our agricultural industry in the peak war year were nearly equal to the task of providing our larger 1950 population with best-adapted diets while still leaving an export surplus of 15 per cent of our total farm production. . . . Such difficulties as will confront agriculture, indeed, are far more likely to arise from problems of surplus production rather than inadequate capacity."

Regarding our natural resources, the Twentieth Century Fund survey concludes: "On the whole, the war left the United States with a depleted supply of most natural resources. . . . However, the depletion of our supply . . . should not prevent the fulfillment of future needs. With relatively free trade throughout the world, we should be able to obtain the raw materials we need to establish a high standard of living in the United States."

Did We "Overbuild" Our Factories in Wartime?

In the matter of industrial capacity, Dr. Dewhurst and his staff estimate that during the war period, "we invested more than $38 billion in new productive facilities, of which manufacturing alone accounted for nearly $26 billion." Many persons fear that we may have "overbuilt" and that the resulting excess capacity will be a drag on our economy—but Dr. Dewhurst points out that a great part of wartime expansion went for strictly military plant and equipment that will be of little use in peacetime. Actual additions to civilian productive equipment went on at a slower rate than normal.

Our Ability to Meet Our Goals

Dr. Dewhurst says: "The end of the war thus found us with more than enough productive capacity to meet normal (though not immediate) postwar requirements for various metal and

chemical products, but with serious deficiencies in our capacity to produce most other goods and services. Neither situation presents difficulties that cannot readily be overcome."

The survey concludes that our estimated labor force of 60 million in 1950 and 63.4 million in 1960, added to our productive resources, make it amply possible for this country not only to produce enough to meet its total estimated needs, but also to provide a substantial margin for expansion and continued rise in output for our entire economic system.

A Major Theme: Productivity

One major theme emerges at many points in the survey: Backing up manpower with machine power is the secret of America's spectacular achievements in both wartime and peacetime production. The report shows that in 1944 we turned out nearly 27 times as much in goods and services as we did in 1850, with a labor force only 8½ times as large, but using 343 times as much mechanical energy in doing so.

"Productivity is the key to future welfare," says Dr. Dewhurst. "The only way to raise the ultimate ceiling on production, which is manpower, is through further increases in output per worker and per man-hour."

Machine, Not Man, Is the Answer

Pointing to the use of machines and inanimate energy as the central factor in this process, Dr. Dewhurst says, "Over the long run the 'efficiency' of the individual worker is a minor element in the productivity of the labor force. The most energetic and skillful shoemaker working long hours with the hand tools of a century ago could not remotely approach the productivity of today's semi-skilled operative, working with the aid of automatic power-driven machinery.

"Over the past century we have achieved a fabulous increase in output per man-hour, not by working harder or more skillfully, but by constantly devising new and better machinery to augment human effort by the use of vast amounts of inanimate energy. What our labor force will be able to turn out in the 1950 decade depends on its size and on future trends in working hours, but more than anything else, on the extent of further gains in productivity."

Past and Future Increases in Rate of Output

In making the survey's main estimates of what the total output of goods and services might be in 1950 and 1960 if our economic system is operated at high levels, Dr. Dewhurst has assumed that productivity will continue to increase at the average rate of increase for all the decades between 1850 and 1940. This average is 18 per cent, and using it as a base the survey estimates 1950's total output of goods and services in the United States at $177 billion and 1960's output at $202 billion. These estimates are in terms of 1944 prices, which are about 16 per cent below present levels. However, increase in productivity, or output per man-hour of work, has shown great variation in the past. It amounted to 42 per cent in the decade 1930 to 1940 and 21 per cent in the decade 1920 to 1930.

Dr. Dewhurst says, "If we could increase output per man-hour at the average rate of the *two decades* before the war, which seems quite possible, we could turn out a gross product of nearly $200 billion in 1950." On the same basis, he estimates a total output of $249 billion would be possible in 1960.

Do Machines Destroy Jobs?

On the question of whether the great increase in the use of machines and mechanical power causes workers to lose their jobs and thus creates "technological unemployment," Dr. Dewhurst observes, "Resistance to the introduction of labor-saving machinery is understandable, for it often results in personal tragedy to the individuals who are displaced. Over the long run, however, it is only through technological disemployment that material progress is possible. . . . What has happened, in reality, has been not only a vast increase in the amount and variety of goods available to the population and a marked advance in labor productivity, but also a steady expansion in the number and proportion of the population in gainful occupations and a progressive shortening of the work-week. With some costly and painful interruptions, we have 'had our cake' in the form of expanding full employment, and 'eaten it' in the form of increased leisure and an ever-higher standard of living."

Hours of Work Go Down as Productivity Goes Up

These striking gains in rate of output have been accompanied by steady reduction in the average number of working hours per week. "At the time of the Civil War," says the report, "the average work-week was close to 70 hours; just before World War I it was still nearly as long on the farms and more than 50 hours a week in nonfarm occupations. By 1940 it had dropped to 43 hours." The Twentieth Century Fund survey assumes that this long-term down trend in working hours will continue, and its estimates of future output are based on an average working week of less than 41 hours in 1950 and 38 hours in 1960.

Mechanical Energy is the Key

In explaining how output goes up while hours of work go down, Dr. Dewhurst comments, "This lessening of human toil and advancement of human welfare has been made possible by harnessing tremendous amounts of mineral energy (coal, oil, water power, etc.) to multiply human effort—with all that this implies in terms of the application of scientific discoveries, engineering and managerial skills and large-scale capital investment."

He shows that "in 1850, when an American workman had to work an hour, on the average,

to produce 23 cents worth of goods, he had the help of only half a horsepower of energy from animals and minerals. By 1900 his hourly output was twice as large, and his effort was supplemented by nearly twice as much nonhuman power. . . . By 1960, if these trends continue, we will be producing six times as much per man-hour as in 1850—with each hour of human effort supplemented by nearly eight times as much nonhuman energy."

We Take Out What We Put In

Dr. Dewhurst concludes, "We have apparently been getting out of our economic system, without major variations from decade to decade, about as much in terms of finished goods and services as we have been putting into it in terms of total energy expended. We produced our 1850 national income with an 'expenditure' of 17.6 billion horsepower-hours of work—a ratio of about 2.8 horsepower-hours per dollar of net output. In 1940, with a total work energy output of 289 billion horsepower-hours, the ratio was about the same. But mineral energy (including water power), which was of negligible importance in producing the 1850 national income, had almost displaced manpower and animal power by 1940."

Future Use of Energy in the United States

Carrying this trend forward, Dr. Dewhurst says, "With the rapid development of electric power and the internal-combustion engine since 1900, minerals have become our dominant source of work energy. In 1940 we used seven times as much mineral energy per man-hour as in 1900 and 70 times as much as in 1850. By 1960, with minerals doing nearly 99 per cent of our nonhuman work for us, we will be using over 100 times as much mineral energy per man-hour as in 1850."

It is, he says, "this phenomenal increase in the use of inanimate energy, which more than anything else accounts for the high standard of living and the economic primacy of the United States in the modern world."

People in the "Power Age"

Analyzing some of the effects of the "power age" on modern living, Dr. Dewhurst points out that "although many a worker in commerce and industry, and especially in agriculture and construction, still has to 'work like a horse' in the traditional meaning of the term, power-driven machinery is now doing most of our work for us—from digging ditches to adding columns of figures. Most occupations in the United States today require more horse sense than horsepower—and take their toll in nervous exhaustion, rather than muscular fatigue."

How Power Helped in Wartime

A striking illustration of how our modern use of power and machinery served us in time of a national crisis is shown in Dr. Dewhurst's analysis of our peak wartime output of nearly $200 billion in goods and services in 1944. He says, "With both working hours and productivity remaining at the 1850 level, we would have required in 1944 a working force of 190 million—three times the number actually employed—to have produced the amount of goods we actually turned out in that year. With the shorter work-week of 1944, an additional 100 million workers would have been required!"

Responsibility of the Individual Worker

In our whole productive effort, Dr. Dewhurst says that the attitudes, capabilities and work habits of the individual worker are important. "On the physiological side, inherited physique, nutrition, living conditions and the quality of family and medical care determine health, vigor and energy. We are fortunate that the educational and medical standards and high level of living in the United States provide high standards of maternal care and child welfare. . . . Some workers . . . are more efficient than others because of better education or greater strength, intelligence and aptitude; and efficiency can be increased by practice and training."

Outlook For the Future

Summing up the outlook for the future, Dr. Dewhurst concludes, "There are good reasons to believe that the technological progress of the past will continue in the future, perhaps at an accelerated rate; but it would be a mistake to assume that further progress is inevitable. Whether we increase output per man-hour during the next decade by 18 per cent or by some other percentage—or not at all—will not be determined by 'projecting past trends.' It will be determined, as it has been in the past, by a multitude of actions and decisions on the part of individuals: inventors, industrial managers, entrepreneurs, investors, workers and consumers. It is this collective decision, conditioned by their hopes and fears, expressed in the halls of government as well as in the market place, that will determine whether we will continue to multiply the fruits of the Power Age."

—C. M. P.

WHITAKER, JOE RUSSELL. *The Life and Death of the Land.* Nashville: Peabody Press, 1946. 118 p. $1.30.

This essay falls into three groups. The first deals with the whole problem of the "Life and death of the land." The second group is concerned more directly with the teaching of conservation, particularly in geography classes. The third, somewhat more technical in style, is concerned with the history and theory of conservation.

People living on any part of the earth tend to wear out the resources which make it habitable and attractive. The most evident way in which this happens is the deliberate removal of resources in order to use them. When two or more resources occur together one may be re-

moved or destroyed in order to use the other. One resource may be damaged because of its proximity to another.

The destruction of natural resources is not without its benefits. Basic needs, quite obviously, depend on the use of natural resources. Resource destruction and impairment are as old as mankind and as widespread as the inhabited portions of the earth. Even very primitive peoples impaired their natural resources. But ours has been the destructive age, and ours the destructive country. There are many reasons why each part of this statement is true. These reasons need not be discussed here. But as a cause of destruction of natural resources, twentieth century wars stand unrivaled.

In teaching conservation, the author says to stress the near future, dwell on the known, use the community. In the grades conservation can best be taught in connection with existing courses such as geography, history, elementary science. In high schools, conservation problems might well take up half a year or year social studies courses. Colleges should offer at least one course open to all students that considers the *whole* problem of conservation.

—C. M. P.

SEARS, PAUL B. *Deserts on the March.* Norman, Oklahoma: University of Oklahoma Press, 1947. 178 p. $2.75.

When this book was first published in 1935 it was soon acclaimed as one of the important books of recent times. The fourteen years since has confirmed this earlier appraisal. In this revised edition new material has been added including an additional chapter, *Deserts in Retreat.*

Louis Bromfield says "This book is one of the important contributions to the life and economy of this nation." Few books have done so much as the earlier book did to bring to the attention of the American people the terrible results to our economy and civilization of the shameful waste of our natural resources and of the even more appalling results which lie ahead of us if the nation does not change its course. In three centuries, the white race has plundered and laid waste a storehouse of natural resources incomparably more valuable than any other known to modern man.

The conservation practices advanced during the depression years were all but abandoned during World War II. Today, we are immeasurably poorer than we were before—not only in that basic substance, soil, but in forest, natural waterways, grasslands, minerals, and wildlife. Our situation is precarious, for these are the subtle elements which, when allowed to do their beneficent work, clothe the earth and provide the sustenance of man.

What shall we do about it? The author shows that intelligent action by the American people can arrest the forces of decline which have already made parts of our continent resemble a desert.

This is a book for every American to read, to ponder about, and seriously and intelligently put into actual operation the practical recommendations made. It is a *must* book for every science and conservation teacher.

—C. M. P.

HARDING, T. SWANN. *Two Blades of Grass.* Norman, Oklahoma: University of Oklahoma Press, 1947. 352 p. $3.50.

This is a history of scientific development in the U. S. Department of Agriculture. Here is proof positive that scientific research in agriculture pays large dividends whether measured in monetary terms, or in scientific advancement, or both.

Dr. T. Swann Harding who has been with the Department of Agriculture more than thirty years is at present an information specialist and editor of USDA, the house organ of the department. He presents an absorbing account of the search for better grains, fruits, and vegetables, for better methods of soil and forest conservation, for prevention of disease in plants and animals, for control and destruction of harmful insects, for preservation of game and wildlife, and for additional economic uses of farm products and by-products.

This is not a dry-as-dust book of reports of scientific research. Dr. Harding is one of the best popularizers of science as those who have read his earlier books will recall. Here are the best examples of what applied science means to agriculture, what it has meant and now means to you and me. It is an excellent reference, replete with accurate information, for the chemistry, biology, general science, elementary science, conservation, and agriculture teacher.

—C. M. P.

CARPENTER, HARRY A., BAILEY, GUY A., AND BAKER, MARY LOUISE. *Adventures in Science with Judy and Joe.* 1948. 92 p.; CARPENTER, HARRY A., BAILEY, GUY A., AND STROETZEL, BERNICE. *Adventures in Science with Bob and Don.* 1948. 138 p.; CARPENTER, HARRY A., BAILEY, GUY A., STROETZEL, BERNICE T., AND EBRITE, ETHEL. *Adventures in Science with Jane and Paul.* 1948. 186 p.; CARPENTER, HARRY A., BAILEY, GUY A., AND TUTTLE, M. ELIZABETH. *Adventures in Science with Doris and Billy; Adventures in Science with Jack and Jill.* 1948. 250 p., 314 p.; CARPENTER, HARRY A., BAILEY, GUY A., AND SMITH, PAUL E., *Adventures in Science with Ruth and Jim,* 1948, 410 p. Boston: Allyn and Bacon.

The Rainbow Series in Elementary Science is one of America's most popular and widely used elementary science series. Popular from their first appearance, they are more widely used now

than at any time. Such popularity through the years is based upon a number of factors. Science specialists have been aided by a reading specialist for each grade. They are characterized by sound, well selected, appropriately graded content.

The titles listed above are in order of grade placement from the first grade through grade six. Illustrations in the first five grades are in color. The illustrations have had great pupil appeal, challenging both his attention and interest. Especial attention has been paid to reading difficulties and scientific terms.

A complete course of study is furnished free to teachers. There is a workbook and teachers manual available for each science reader. Many suggested learning activities, things to do, experiments, drill exercises, problems to solve and main ideas summarized, are included. Both experienced and inexperienced teachers will gain in confidence and competency as they use this challenging series of elementary science books.

—C. M. P.

EVANS, EVA KNOX. *Life Around Us.* New York: Hinds, Hayden and Eldredge, Inc. 1948. 246 p.

This is the first book of the *Better Living* series. It seems to be suitable for about the second grade or the end of the first grade. There are many interesting stories for children about houses, the school bus, school, the store, Thanksgiving, Christmas, trucks food, wash day, picnics, the chicken house, Easter, the last day of school, and so on. The vocabulary has been carefully selected. Many pictures in color, the pleasing appearance, well-selected stories, and the readable type combine to make this an unusually attractive book.

—F. M. D.

ROSEBURY, THEODOR. *Experimental Air-Borne Infection.* Baltimore: The Williams and Wilkins Company, 1947. 222 p. $4.00.

This report presents the major results of a cooperative wartime project to which many persons contributed. The cloud chamber project was instituted at Camp Detrick, Maryland, in December, 1943. Its assigned task was to devise and set up an installation equipped for the study of air-borne clouds of highly effective agents under conditions of safety to the operating personnel and others, and in a manner such as to elicit reproducible quantitative data on infection of small laboratory animals by the inhalation route. The results of this project are here reported.

The experiment was quite successful. Satisfactory methods were developed for the quantitative study of infective clouds. Among the bacterial agents studied, *Pasteurella tularensis* and *Malleomyces pseudomallei* were found to be first and second respectively, in order both of infectivity and lethality.

—S. M. A.

MULLER, H. J., LITTLE, C. C., AND SNYDER, LAWRENCE H. *Genetics, Medicine, and Man.* Ithaca, New York: Cornell University Press, 1947. 158 p. $2.25.

This is an introduction to the facts and principles of heredity—the science of genetics—and the application of this knowledge to problems of human health and welfare. It comprises the six Messenger Lectures delivered at Cornell University on the *Evolution of Civilization.* The authors are among the world's best known geneticists. Dr. Muller was awarded the Nobel Prize in Medicine and Physiology in 1946.

The science of genetics has made tremendous advances in less than half a century. Recently important advances have been made in relation of heredity to health and disease.

Laymen will have little difficulty in reading and understanding most of the treatise. Biology teachers should find it informative and challenging. Many will find the chapters on human heredity of greatest interest.

Specific practical applications to human heredity have been developed in: 1. genetic prognosis, that is, the furnishing of genetic advice in prospective marriages and prospective families; 2. diagnosis on the basis of genetic data, on conditions difficult to identify by other means; 3. instituting of preventive measures against certain diseases and abnormalities, on the basis of specific genetic backgrounds; 4. determination of non-paternity, and other medico-legal problems, on the basis of test characters, particularly the blood agglutinogens; and 5. recommendation of eugenic programs for the protection and improvement of society.

Twenty-nine human traits are listed as dependent upon sex-linked genes; ten others are listed as recessive lethals.

—J. O. S.

MCFARLAND, J. HORACE. *Modern Roses III.* Harrisburg, Pennsylvania: J. Horace McFarland Company, 1947. 286 p. $5.75.

This book was prepared in cooperation with the American Rose Society. It is a descriptive list of all roses in commerce or of historical or botanical importance. It gives the genealogy and a brief accurate description of 5,284 roses, including 296 species. Roses are listed alphabetically. Amateur rose growers, plant breeders, teachers, students, general readers will find here complete information on every known American rose. There are many color plates.

—J. O. S.

PRESTON, JR., RICHARD J. *North American Trees.* Ames, Iowa: The Iowa State College Press, 1948. 428 p. $4.00.

North American Trees has been designed to meet the needs of an interested nontechnical public as well as a working field manual for professional and classroom use.

The manual covers the trees of North America with the exception of Mexico and the trop-

ical trees found in the southern fringe of the United States. A total of 568 species are described with full page plates with descriptive characters and distribution maps for 232 of the most important species. All descriptions, complete on one page facing the illustrative plate, include habitat, leaves, flowers, fruit, wood, twigs, bark and silvical characters.

The author is professor of forestry, North Carolina State College.

—G. B. K.

PERCIVAL, OLIVE. *Our Old-Fashioned Flowers.* Los Angeles: The Ward Ritchie Press, 1947. 245 p. $5.00.

To those who love and have a fond remembrance for old-fashioned flowers this book will be a delight. The first chapter of thirty-five pages traces the sources of names of many of the old-fashioned flowers, the folk-lore which enshrouds many of them.

Many of the old-fashioned flowers had several names. The author lists the Latin botanical name followed by the one or more English names. One list is for herbs, vines, and undershrubs; another is a short list of old-fashioned roses; a third list for herbs. There is an excellent bibliography followed by a flower index in which the English name is listed first.

Altogether this is a book that will be a joy to all flower fanciers, especially those who love old-fashioned roses and other flowers.

—J. O. S.

HAZARD, JOSEPH T. *Our Living Forests.* Seattle: Superior Publishing Company, 1948. 302 p. $4.00.

Forests in the natural state are beautiful, yet prodigal and wasteful. The multiple use of trees and forests is the message of this book. Seven major fields are considered in the multiple use of forests: the forest industries; the grazing of flocks and herds; prospecting and mining; water resources; wild life and game; recreation; rest, relaxation, and health-seeking.

The author writes with a literary style that is refreshing and enjoyable. Man followed the forests west through America. But whether talking about famous trees, the timber barons, ruthless logging and business methods, planting trees, proper forest conservation methods or the enemies of the forests, each chapter is excellent reading. Here is a recommended book for the high school science library, the elementary science, general science, and biology teacher, and any one loving the forests and interested in their proper use.

—G. B. K.

CLAYTON, H. HELM AND CLAYTON, FRANCES L. *World Weather Records.* Washington: Smithsonian Institution, 1947. 646 p.

This is a continuation of two previous volumes, the first containing information from the earliest available observations up to 1920, the second from 1920 to 1930, and this volume from 1930 to 1940. The data in this volume is arranged alphabetically and is quite complete. If you want to know about the weather any place in the world, you can in all probability find it given here for every month of the ten-year period, together with the monthly means for the ten-year period.

—C. M. P.

ABBOT, C. G. *The Sun's Short Regular Variation and Its Large Effect on Terrestrial Temperatures.* Washington: Smithsonian Institution, 1947. 33 p. $0.30.

The author is the world's best known authority on solar radiation. The major thesis of this treatise is based on the author's study of solar variation dating back to the early thirties. Later supplementary data dating back to 1910 were used. He seemingly has positive proof that the sun has a regular period of 6.6456 days in solar variation and that terrestrial temperatures respond with changes ranging from 2° to 20° F. in exactly the average period of recurrence. Temperature effects seem to commence 2 or 3 days *before* the beginning of a change in the solar constant of radiation. Temperature forecasts of the order of a month in advance may now be practicable with the aid of this new cycle.

—C. M. P.

FINDLAY, ALEXANDER. *A Hundred Years of Chemistry.* New York: The Macmillan Company, 1948. 318 p. $4.50.

This is one of a *Hundred Years* series of Macmillan books. The first edition of this book was published in 1937. The great advances in chemistry during the last decade has necessitated the revision of the earlier well received volume. The period originally covered was 1835–1935. There is a very brief summary of the earlier historical backgrounds of chemistry. Numerous short biographical sketches of leading chemists add much to the value and interest of the book.

The author is Emeritus-Professor of Chemistry in the University of Aberdeen.

—G. B. K.

DEKNIGHT, FREDA. *A Date with A Dish.* New York: Hermitage Press, Inc., 1948. 426 p. $3.00.

This is a volume of American Negro recipes that includes recipes, cooking hints, and menus from all over the country. The recipes have been tested for the average cook to master and the family to enjoy. The volume is completely indexed. Directions are direct, clearly stated, and for the most part do not call for elaborate ingredients. The author has acted as teacher and counsellor in the New York schools and has been for many years the Cooking Editor of the magazine, *Ebony.*

—G. B. K.

HAUGAN, RANDOLPH E. *Christmas.* Minneapolis: Augsburg Publishing House, 1948. 67 p. $1.00.

This is volume eighteen of an American Annual of Christmas literature and art. It is an unusually beautiful book with several famous art pictures reproduced in water color and kodachrome. Christmas articles, stories, poetry, music, art, and photography comprise the major features of this artistic book. It is a beautiful book to have and to give.

—F. M. D.

HAUSMANN, ERICH. *Swoope's Lessons in Practical Electricity.* New York: D. Van Nostrand Company, Inc., 1948. 769 p. $4.80.

This is the eighteenth edition of a text first published in 1901 by Coates Walton Swoope. This edition has been completely rewritten and revised. Its long and wide usage attests to the success of the earlier editions. In difficulty it is about that of the electricity sections of college texts in beginning physics. There are directions for conducting 115 experiments. Many practical problems and situations are included.

—S. M. A.

SHANNON, JAMES I. *The Amazing Electron.* Milwaukee: The Bruce Publishing Company, 1946. 248 p. $4.00.

The title for this book is quite apt. Like many similar books in recent years the author retells the interesting story of scientific research on the structure of the atom. Here the story is rather completely and interestingly retold. The treatise is more technical than that found in some recent books for the laymen. However, laymen with a good high school chemistry and physics background can read this book with ease. It is more to be recommended for the high school physics and chemistry teacher and student, or students in college courses in those areas, or in physical science survey.

The work is well done and quite accurate. The author is head of the Physics Department at St. Louis University.

—J. O. S.

WORTHEN, EDMUND L. *Farm Soils: Their Management and Fertilization.* New York: John Wiley and Sons, Inc. 1948. 510 p. $3.24.

Success in farming requires a knowledge of the soil and skill in its management. The soil is America's most important resource. Upon its efficient use the destiny of the nation depends. This valuable heritage has been wantonly used. It is encouraging to note that we now realize that fact.

This is a practicable book written in simple, understandable language. Most aspects of soil conservation and management are discussed. General science, elementary science, and biology teachers will find this a most practicable reference.

—S. M. A.

YATES, RAYMOND F. *The Niagara Story.* Buffalo, New York: Foster and Stewart Publishing Corporation, 1948. 56 p. $1.00.

This is a pictorial guide to Niagara Falls. *The Niagara Story* is written as a running commentary in connection with an imaginary visit to each place of interest outlined in the pages that follow. Much historical information of absorbing interest is included. As the author quotes John J. Audubon: "All of the pictures you may see, all of the descriptions you may read of these mighty falls, can only produce in your mind the faint glimmer of the glowworm compared with the overpowering glory of the Meridian sun." Audubon is absolutely correct. It is beyond description. Numerous photographs supplement the descriptive material.

—F. M. D.

MULDOON, HUGH C. *Organic Chemistry.* Philadelphia: The Blakiston Company, 1948. 648 p.

This is the third edition of a text first published in 1927. It is designed for beginners. This third edition represents a thorough recruiting, is expanded, enriched, and modernized. Sequence of some topics has been changed. More material is included than the average student will be expected to remember, but not more than he can understand and assimilate.

—S. M. A.

PORTER, C. W. AND STEWART, T. D. *The Essentials of Organic Chemistry.* Boston: Ginn and Company, 1948. 394 p. $4.00.

This is a new book of organic chemistry intended for a one-year semester course. Everyday life situations are used in treating familiar materials. It is for students of medicine, dentistry, public health, agriculture, home economics, and students in general courses of arts and science. The authors are professors of chemistry at the University of California.

—S. M. A.

CURTIS, WINTERTON C. AND GUTHRIE, MARY J. *Laboratory Directions in General Zoology.* New York: John Wiley and Sons, Inc. 1948. 236 p. $2.00.

This is the fourth edition of a laboratory manual first published in 1925. No radical changes have been made in this edition. The work on genetics and also the animal kingdom (survey and classification) have been expanded. Some additional drawings have been included. Student drawings, answers to questions, and comments must be made in a separate notebook.

—S. M. A.

ROSS, HERBERT H. *A Textbook of Entomology.* New York: John Wiley and Sons, Inc., 1948. 532 p. $6.00.

This introductory text is intended to give the beginning student a general idea of the entire field of entomology. Unlike most books, this one traces very briefly the development of entomol-

ogy. Insect physiology is treated separately. The basic relationships and biologies of the insect orders are presented. There are 434 figures and illustrations.

The author since 1931 has been Systematic Entomologist for the Illinois State Natural History Survey and is also Professor of Entomology at the University of Illinois.

This book will serve as an excellent reference for the high school biology, the general science teacher, and elementary science teacher.

—C. M. P.

PATTEN, BRADLEY M. *Embryology of the Pig.* Philadelphia: The Blakiston Company, 1948. 352 p. $3.75.

This is the third edition of a text first published in 1927. Stress is laid upon embryologic phenomena. There are 186 illustrations, many in color.

—S. M. A.

DEROBERTIS, E. D. P., NOWINSKI, W. W. AND SAEZ, FRANCISCO A. *General Cytology.* Philadelphia: W. B. Saunders Company, 1948. 345 p. $5.50.

This is a revision of a book first published in Argentina in 1946. Many changes were made in the original and thirty-four new illustrations added. Morphological, physiological, and genetic aspects of modern cytology are stressed. Modern technique derived from physics and biochemistry are described.

—S. M. A.

DAWSON, HELEN L. *Lambert's Histology.* Philadelphia: The Blakiston Company, 1948. 696 p.

This is the second edition of a text first published in 1938. It is for beginning students and the functional significance of the cells, tissues, and organs of the body are stressed. There are nearly 300 illustrations, some in color.

—J. O. S.

BRITTAIN, MARY Z. *Arab Lands.* New York: Holiday House, Inc. 1947. 24 p. $1.25.

Both ancient and modern history meet in the Arab lands of the Middle East. No other region is so packed with history, few regions more desolate geographically, so important geologically. Illustrations are by Rafaello Busoni. A better knowledge of these Arab lands of the complex, turbulent Middle East is highly important at the present time. They may well shape the destiny of the world for some time to come.

—E. D.

DAVIS, ROBERT. *France.* New York: Holiday House, Inc. 1947. 24 p. $1.25.

This is one of the *Other Lands and Peoples* series of geography books. Something of the history and backgrounds of the people of France is first presented with a major emphasis upon the geographic, economic and political influences that have shaped the lives of the French people. Illustrations by Rafaello Busoni add much to the interest and attractiveness of the book. Here is excellent background for a better understanding of our friend across the sea.

—E. D.

EVANS, EDWIN BEN. *Scandinavia.* New York: Holiday House, Inc. 1948. 24 p. $1.25.

Scandinavia is another title in the *Other Lands and Peoples* series. The author is an American teacher who knows the Scandinavian people intimately. Scandinavians are a hearty, hard-working people who have made democracy practicable, individualistic, and joyous. Illustrations are by Rafaello Busoni.

—E. D.

LIVINGTON, ROBERT. *Physico Chemical Experiments.* New York: The Macmillan Company, 1948. 267 p. $3.50.

Forty-two experiments in physical chemistry are described in this second revision of a laboratory manual first published in 1939. The first chapter discusses measurements, errors, and computations.

—J. O. S.

BOOTH, A. D. *Fourier Technique in X-Ray Organic Structure Analysis.* New York: The Macmillan Company, 1948. 106 p. $2.75.

This is a comprehensive account of the Fourier methods in organic crystal structure determination, including accurate assignments of bond lengths and angles in complex substances.

—S. M. A.

SCHILLINGER, JOSEPH. *The Mathematical Basis of the Arts.* New York: Philosophical Library, 1948. 696 p. $12.00.

This in an attempt to link together on a mathematical basis the arts of music, literature, and the space arts. The author reveals the fundamental mathematical laws of structure underlying plant and animal life. An attempt is made, seemingly successful, to replace the "trial and error" method of artists with one that is logical and easy of application.

Mathematicians, engineers, scientists and artists (painters, composers, motion picture technicians, industrial designers) will find the treatise stimulating. The work is both speculative and technical.

—C. M. P.

DEGRAZIA, JOSEPH. *Math Is Fun.* New York: The Gresham Press, 1948. 159 pp. $2.75.

Math is fun, and entertainment, too, when the problems are so intriguing and brain-teasing as those formulated by Doctor Degrazia. The problems have been devised by the author over a period of twenty-five years. A few of the problems are difficult, but none need more than a high school knowledge of mathematics. There are a number of humorous drawings by Arthur M. Kraft. There are 196 problems. Solutions are given in the back—just for checking up purposes!

—C. M. P.

THE CAMERA. *Portraiture.* Baltimore (306 N. Charles Street): The Camera, 1947. 192 p. $3.50.

Fifteen foremost experts in their respective fields of portraiture have contributed to this volume. More than 250 illustrations accompany the wealth of practical knowledge. You learn how to photograph men and women wearing glasses, stout people and thin people, children, groups, three quarter and full lengths, backgrounds and lights, what to do about eyebrows, ears, hair-dos, lipstick, and make-up, and so on.

Any photographer will find this easy-to-read, easy-to-follow book a great help in making portraits. Even amateurs in their own home can become quite expert in portrait photography by following the suggestions outlined.

—J. O. S.

BELL, H. S. *Oil Shales and Shale Oils.* New York: D. Van Nostrand Company, Inc., 1948. 157 pp. $4.00.

Interest in obtaining oil from oil shale is likely to increase rapidly in the not too distant future. The first mention of obtaining oil from rock was a British patent of 1694. The first commercial exploitation of oil from shale took place in France from 1839 to 1865. The average yield was about 24 gallons per ton of shale.

Oil shales of commercial value are found in France, Scotland, Australia, Manchuria, Estonia, Sweden, Canada, Brazil, and the United States. It is estimated that the United States has oil shale deposits from which oil may be recoverable to last us about 85–90 years based on 1947 consumption. The five leading states in order: Colorado, Utah, Kentucky, Indiana, and Wyoming.

There are chapters on characteristics of shale and shale oils, mining methods, preparation of shale rock, retorting, refining, and relative costs.

—C. M. P.

SPENCER, CORNELIA SPENCER. *Japan.* New York: Holiday House, Inc., 1948. 24 p. $1.25.

This *Other Lands and Peoples* book emphasizes the backgrounds of the peoples of Japan—culturally, geographically, economically, politically. It explains why the Japanese are extremely painstaking, obedient, imitative. The perils and hardships on the crowded islands are vividly impressed. To many, the Japanese have always been something of an enigma, but what they have been longing for all of the time is to be secure, to be equal, to be honored as a people. As in the other books of the series, there are fascinating illustrations by Rafaello Busoni.

—E. D.

HINES, DUNCAN. *Vacation Guide.* New York: Duncan Hines, Inc., 1948. 371 p. $1.75.

This Duncan Hines *Vacation Guide* lists good places to spend an enjoyable vacation. In the main he has selected places accommodating 25 people or more, where one is likely to spend a week or more, and where more than sleeping accommodations are offered. Whatever type of vacation you may want, you will find it described here—whether its dancing, boating, fishing, swimming, golf, skiing, horseback riding. Annual events are listed. Many suggestive tips are offered for a more pleasant vacation. Vacation places are listed alphabetically by states. Canada, the Bahama Islands, Bermuda, and Mexico are included. Interesting information about each state is given. Photographs and clever cartoons are interspersed here and there.

—F. M. D.

BRUNSON, MRS. DEWITT AND DOWLING, THOMAS I. (Editors). Suggestions for the Teaching of Science in the Twelve-Year School Program. Columbia, South Carolina: State Department of Education. 115 p.

This is a cooperative enterprise that involved the cooperative efforts of most of the teachers of South Carolina. Science is made one of the major teaching areas in the twelve-year program. Consequently this bulletin is especially timely for all teachers in the South Carolina Public Schools. Science teachers in other states will find many useful suggestions.

The first chapter discusses the purposes of public education. The rest of the bulletin is given over to teaching of science from the primary level through the senior high school. Aims, content, methods, demonstrations, references, films, equipment for each division of science is included.

South Carolina has taken a long step forward in promoting better science teaching at all school levels. All other states that have not already done so would seem to be lagging behind the best thought in public education.

—C. M. P.

PRICE, GEORGE MCREADY. *Common Sense Geology.* Mountain View, California: Pacific Press Publishing Association, 1946. 239 p. $2.00.

As in the author's earlier college textbook, *The New Geology* and other writings, he advances the thesis that the modern theory of *Uniformity or Uniformism* is altogether wrong. In its place he substitutes his own universal *Flood Theory* as the most reasonable explanation of what we find recorded in the rocks. The universal flood idea described in the Bible and common to the folklore of many peoples was an actual geological fact according to the author. Deposition of rock deposits was often made in a hurry says the author. Geological time has not been nearly so long as is now usually assumed. The author believes his theory accounts for many facts not explained by more commonly held hypotheses. It is probably true that few if any geologists will agree with Price's Flood Theory. All of which goes to show that very few theories have complete acceptance by everyone.

—G. B. K.

KRAUSKOPF, KONRAD B. *Fundamentals of Physical Science.* New York: McGraw-Hill Book Company, 1948. 676 p. $4.50.

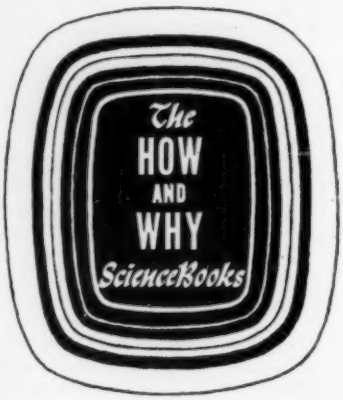
This second edition of a well-received modern survey of the sciences other than the biological is an outstanding contribution in its field. The reader could wish for a more extensive revision than is here observed, but even in its earlier form the text has a unique appeal as a limited overview of much of the physical science field for the non-technical student. What appeals particularly to the reviewer is not necessarily that which will appeal to the teacher or to the student. For instance, the whole subject is introduced by astronomy in well-measured doses, with interruptions of the story to comment on certain fundamentals of simple mathematics and again to discuss the laws of motion, force, and energy. This has good psychological rather than so-called "logical" support. But it may in a measure disquiet the teacher or student who would rather have all of his astronomy while he is "at it" rather than to find his astronomy scattered from one end of the book to the other. However, in actual use, after overcoming the occasional predudice, the teacher or student can happily accept this treatment. The attack is modern, with historical, critical, and psychological attention to items as the occasion seems to demand. In all texts designed for the general public it is difficult to be rigorous in exactitude. Knauskopf is not an exception and makes a number of statements that do not bear too close analysis. The teacher must be on his guard for these cases and teach the student to detect such aberrations when they are met. On the whole the text is very readable with interesting discussion, thought-provoking-questions and problems, and good illustrations. In practice it is a bit strenuous for the poorly trained student, those with inferior science and mathematics (especially algebra) background. The resourceful teacher can supplement this need by incidental teaching.

—F. A. R.

SYMPOSIUM. *Science in Everyday Living.* Brooklyn (110 Livingston Street): Board of Education of the City of New York, 1948. 87 p.

This is a progress report of source materials for early grades and educational use of a natural area. Dr. Jerome Metzner, of the staff of The Bronx High School of Science, served as coordinator, was responsible for the organization of the bulletin as a whole, and the preparation of the material on the *Educational Use of a Natural Area.*

The point of view of this bulletin is that science experiences should be a general part of the curriculum rather than a separate subject in the curriculum. The source materials were developed in one district but are usable in many other school areas. The experiences and activities outlined were developed for the most part for grades K-2, but are suitable for higher grades. For the most part the science experiences are planned to help pupils solve problems —pupils need to learn "how to do things."



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The last and larger unit is one on *The Educational Use of a Natural Area.*

Elementary science teachers everywhere will find many suggestive teaching techniques and most desirable content in this bulletin.

—C. M. P.

STRUIK, DIRK J. *A Concise History of Mathematics, Volumes I and II.* New York: Dover Publications, Inc., 1948, 299 p. $3.00.

Volume I treats from the beginnings to the seventeenth century. Volume II covers the period beginning with the seventeenth through the nineteenth century. The author is professor of mathematics at the Massachusetts Institute of Technology.

While the volumes are of prime interest to teachers and others directly concerned with mathematics, the treatment is non-mathematical for the most part and easily readable by the average layman. Many unusual and interesting facts are presented. Mathematics teachers and students will enjoy and profit from the reading of these small, compact volumes. —C. M. P.

ANDREWS JR., HENRY N. *Ancient Plants and the World They Lived In.* Ithaca: Comstock Publishing Company, Inc., 1947. 279 p. $4.50.

Living things have existed and left at least a fragmentary record in the earth for upwards of half a billion years; man has existed for perhaps a million years and his serious interest in fossil plants goes back hardly 150 years. Neither the Greeks nor the Romans paid any attention to fossils. Prior to Leonardo da Vinci (fifteenth century) fossils were regarded as "mineral accidents" or were a result of the Great Flood which thoroughly mixed up the earth's crust and most of its inhabitants depositing them "according to specific gravitation." But it is clear from his writings that Leonardo understood the origin of fossils. But his work was wholly ignored and it wasn't until the early nineteenth century that the present concept of the origin of fossils gained a permanent foothold.

This is one of the few popular, readable, paleobotanical books that have been published, and one of the best and most readable. It gives one a quite complete picture of the plant life of the past as present day scientists have reconstructed it. The author leads the reader "behind the scenes" as it were, and relates many interesting incidents of his research studies.

One of the most interesting chapters is that on the ginkgo—a true "living fossil" out of the ancient past. It has come down from late Mesozoic times almost unchanged and its ancestors before that period can be traced back another hundred million years. Its fossils are scattered over the surface of the earth. It is found today growing in many American public parks, private estates, and college campuses. It was imported into America from temple gardens of China and Japan. There is disagreement as to whether it grows as a wild plant anywhere in the world.

Then there are interesting chapters on the sequoia, cycads, lepidodendrons, calamites, selaginella, the ferns, pines, and so on. Nearly 170 plates and illustrations add to the interest of the book. This is truly an unusually fine book on the plant life of the past, valuable to science teachers on all levels. —C. M. P.

PHILLIPS, M. C. *More Than Skin Deep.* New York: Richard R. Smith, 1948. 200 p. $2.50.

Reminiscent of the earlier best seller, *Skin Deep,* by the same author, this new volume *More Than Skin Deep* points out that there are no miracles, no magical effects, no rare or precious ingredients in cosmetics. Invaluable and practical advice is given as to what results may be expected by those who use cosmetics. Cosmetics can accomplish only certain effects and those who expect more are only in for more disillusionment. The human race—yes, men too—has used cosmetics from the dawn of civilization. It is quite likely it always will. But that is no reason for not knowing what results may be expected and exactly what one is getting for his money.

The author discusses cosmetics of an earlier day, cosmetic advertising, care of the hair, protection of the unwary, hair dyes, make-up preparations, depilatories and deodorants, cosmetic creams, keeping the weight down, and what cosmetics will and will not do.

More Than Skin Deep will serve as an excellent reference for classes in consumer education. —G. B. K.

KENNON, WILLIAM LEE. *Astronomy.* Boston: Ginn and Company, 1948. 737 p. $5.50.

With the coming into use this year of the Mt. Palomar 200-inch telescope, the attention of both students and laymen will be centered on astronomy more than usual. This textbook is most timely in meeting the needs and interests of those desiring additional information about the celestial universe in which they live. The book is replete with numerous photographs and diagrams, and the treatment of various phases of astronomy is quite complete. A wealth of information is available to those desiring an authoritative source for their astronomical knowledge. So much material is included that much of it would necessarily have to be omitted if the beginning course in astronomy is to be a one-semester course. This can be done without seriously impairing the excellence of the material selected.

G. B. K.

CARLSON, ANTON J. AND JOHNSON, VICTOR. *The Machinery of the Body.* Chicago: University of Chicago Press, 1948. 639 p. $4.50.

This is the third edition of a book first published in 1937. The earlier editions have been most popular and have been used in numerous biological science survey courses as well as in physiology classes. It is indeed one of the finest books in its field that the reviewer has ever used or read. Biology and elementary science teachers will find it an unusually fine reference.

C. M. P.

POTTER, EDITH L. *Fundamentals of Human Reproduction.* New York: McGraw-Hill Book Company, 1948. 231 p. $3.50.

Fundamentals of Human Reproduction has been written especially for nurses, but medical students and laymen will find the book of great interest and value because of its simplicity, especially in its treatment of embryology. The processes concerned with the development of each organ of the human body are discussed. Many illustrations and some excellent photographs supplement the textual material.

S. M. A.

EYRING, CARL F. *Essentials of Physics.* New York: Prentice-Hall, Inc. 1948. 422 p. $3.75.

Essentials of Physics was first published in 1934 under the title *A Survey Course in Physics.* It is a text intended for the non-technical liberal arts student. Applications familiar to students

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in home economics, physical education, music, art, and literature are used. New developments in physics are discussed. A minimum of mathematical knowledge is assumed. Survey courses in physics would find the book most useful. It is probably no more difficult, if as difficult, as many high school texts of physics.

C. M. P.

HORNING, J. L. *Radar Primer.* New York: McGraw-Hill Book Company, Inc., 1948. 218 p. $2.80.

In recent years a large number of high school students have shown an interest in the field of electronics. This book is an attempt to explain to them, in a nonmathematical manner, the fundamental principles of radar. It is also designed to appeal to radio operators, radio technicians, navigators and science teachers who would like to learn more about the applications of microwaves.

A previous knowledge of the princples of radio theory or of electricity is not required to read this book. However, in order to follow many of the examples and analogies, the reader should have an understanding of the basic principles of light and sound propagation and reflection.

There is a marked emphasis upon peacetime, rather than wartime applications of radar. The author also discusses other electronic devices which make use of the cathode-ray tube, such as television receivers, Loran navigation systems, and Sonar depth-finding equipment.

The book is profusely illustrated with clear drawings and photographs. Instead of using schematic diagrams which might prove confusing to the beginner, the author has used the much clearer and less detailed block diagram.

To aid teacher and student, the author has included a group of well-designed study questions at the end of each of the eight chapters. He has included a most useful chapter on the history of radar and a fairly complete bibliography listing suggested reference readings in the fields of radar, radio, and television.

The author might have made the book even more valuable to the teacher by including a list of films and filmstrips on these subjects, and a glossary of technical terms. However, this book will be helpful to science teachers who have been looking for a clearly written textbook in this field on the secondary-school level. It will also serve a purpose in high school and vocational school courses in electronics and radio, as an excellent foundation for more advanced study of this rapidly expanding field. —H. S. S.

CAMP, RAYMOND R. *The Hunter's Encyclopedia.* Harrisburg, Pennsylvania: Stackpole and Heck, Inc. 1948. 1152 p. $17.50.

This encyclopedia is a distinctive achievement in scientific and artistic effort. It is said to be the first complete reference work on North American game and hunting. Every effort was made to assure scientific accuracy and complete coverage. Articles on specific topics have been contributed by authorities in that particular field. Correct answers are supplied to every question that any person is likely to ask. Photographs, (many in color) illustrations, and sketches are numerous.

This is a book to thrill every hunter and sportsman. Much useful information for the science teacher is also found throughout the book. To enumerate the topics discussed would require considerable space. A few of the major divisions include: big game, small game, animal predators, winged predators, small mammals, upland game birds, shorebirds, waterfowl, upland game birds, dogs, camp foods and cooking, camp and home game recipes, what to do when lost, etc.

—G. B. K.

WOLFF, WERNER. *Diagrams of the Unconscious.* New York: Grune and Stratton, 1948. 423 p. $8.00.

There has been much speculation on what relation existed, if any, between handwriting and personality. Dr. Werner Wolff, pioneering psychologist at Bard College has analyzed and measured thousands of signatures—the graphic gestures of people. In this book he presents detailed scientific proof that culminates in the formulation of new psychological laws. The book is full of clues to constancy of character, latent traits, true and masked behavior. Emotions, remembrances, expectations are projected into signatures which reveal past behavior and make future prediction possible. Diagrams will assume an important role in the teaching of psychology in the future.

Much experimental work is reproduced. The work is replete with illustrations and handwriting samples, with an accompanying analysis. Included are tables of indicators of graphic expression. The act of handwriting is accompanied by associations, conscious or unconscious. The last chapter presents an analysis and comparison of the handwritings and known life characteristics of seven individuals, including Lincoln, Kant, Spinoza and Ludwig II.

The acid test of the practical results of this study will be the ability of other psychologists to repeat and master the techniques presented. Can it be done? The author believes it can.

—J. O. S.

REISER, OLIVER L. *World Philosophy: A Search for Synthesis.* Pittsburgh: University of Pittsburgh Press, 1948. 127 p. $2.50.

Scientific humanism is the name proposed for the collective pool of knowledge and vision which, it is hoped, will unify and integrate the values and achievements in the sciences, the humanities, and man's esthetic and religious interests. It is an effort to see life as a whole. That is what Dr. Reiser attempts in this book. The author is a professor of philosophy at the University of Pittsburgh. Altogether the book is most readable, and challenging, with quite a large emphasis upon science and its contributions to the whole of life. —J. O. S.

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INTRODUCING THE CONTRIBUTORS

(Continued from page 6)

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